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COMMON SENSE APPLIED TO THE TARIFF QUESTION.

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I.

ACCORDING to the English theory and practice of representative government, from which our own methods have been derived (subject, however, to some variations of doubtful expediency), it is the function of a Minister of Finance, named in this country Secretary of the Treasury, to prepare a budget or estimate of income and expenditures. At each session of the British Parliament specific expenditures are recommended, and specific sources of revenue are set off, which have been carefully computed, so that it may be hoped or expected that revenue and expenditure will balance.

Any one conversant with the financial history of Great Britain will long since have ceased to wonder at the accuracy of these estimates. If a probable surplus in revenue is expected from existing taxation, the Chancellor of the Exchequer frames such measures of relief from taxation as may be assumed to yield the greatest benefit to the tax-payers. If, on the other hand, any extraordinary expenses are to be provided for in the ensuing year, then specific additions to taxation are recommended in order to provide the necessary ways and means. Under these conditions the opening speech of the Chancellor of the Exchequer when he presents the budget, so called, becomes the subject of most careful public attention. The reputation of leaders in Parliament is established or is lost by their ability to deal with financial questions. Ministries stand or fall according to the ability of the leader of the party to satisfy the public of his sound judgment in dealing with the matter of public taxation. Thus, while the reputation of the leaders of the House of Commons on either side

is made or marred by their power of dealing with revenue questions, yet, in order to enable them to do so with intelligence, permanent officials are kept in office in the civil service of Government through all party changes. These permanent secretaries are charged with the duty of keeping the public accounts in such a way that, in spite even of revolutionary changes in party politics, the continuity of the financial history and of the records of account may be maintained with absolute integrity of purpose, so that there may be no break in the established system, whoever may be in power.

The names of Robert Giffen, permanent Secretary of the Board of Trade; of Sir Thomas H. Farrar, who for more than fifty years occupied a most important position in the service of the Treasury of Great Britain; and the name of the late Sir Louis Mallet, for many years permanent Secretary of the India Board, are well known to every economic student both here and abroad.

When one fully comprehends these conditions under which the conduct of the finances of Great Britain has been carried on for many generations, it no longer remains a matter of surprise that the knowledge of these subjects among the people of Great Britain is far above that of the people in our own country. The financial debates in Parliament are also so far above those of our own Congress as to leave little room for comparison. With a few conspicuous exceptions among our Representatives and Senators, there is hardly a man capable of making a financial speech that is worth any attention on the part of a student. There are many speeches delivered which contain valuable information, but these are mostly compiled in the party bureaus either by the clerks of committees or by others who are conversant with affairs, generally men who are competent to meet the requisitions of members when they desire to address their constituents through the medium of the Congressional Record.

When any great financial debate comes up in the British Parliament there is hardly a speech made which is not worth close attention, or which does not stand for the convictions of the speaker, based on his own knowledge of the subject.

The proceedings in our Congress offer a severe contrast. Witness the customary course in the treatment of financial questions. The annual report of the Secretary of the Treasury is laid upon the table of the several committees, who immediately ignore all the recommendations of the Secretary. The Committee on Appropriations immediately proceed to recommend the expenditures without any regard to revenue; while the Finance Committee in the Senate and the Ways and Means Committee in the House at once proceed to consider revenue measures without any reference whatever to ways and means, and with scarcely any atten-

tion to the appropriations, except when the appropriations become so extravagant as to hazard the success of the party in power.

Such have been the conditions under which revenue measures have been treated by the present Congress, finally resulting in an act the avowed purpose of which is to diminish the revenue by increasing taxation, and to divert the increase of taxation from the Treasury of the United States to the support of private enterprises, either by direct bounty, as is proposed in the case of sugar, or by indirect contribution, as in the case of tin plates and other matters.

What other description can be given to a revenue measure framed upon the new theory of protecting—that is to say, of providing by public taxation the ways and means by which a specific branch of private industry may be supported, with the incidental purpose of yielding a lessening revenue to the public treasury?

It has therefore seemed to me expedient that one who has been studying the financial questions of this country for more than twenty-five years might rightly assume the functions with which the permanent civil officers of the British Parliament are charged, viz., that of preparing a budget by sorting national expenditures according to their kind, and by placing specific sources of revenue against the different elements of the public appropriations.

The writer may not presume to rival the Chancellor of the Exchequer or the Secretary of the Treasury. It is their function to deal as statesmen with the facts that are prepared for them by those who are conversant with all the existing financial conditions.

The time has come when it is the duty of every man who may be assumed to have some exact knowledge upon the subject of taxation, to present his views when called upon in a simple, plain way, without regard to his own private interests, whatever they may be.

Before coming to the main subject, I beg to say that I should myself find it somewhat difficult to characterize my essay by any distinctive title which would be theoretically correct. I observe that my work, my figures, and my views are quoted by one party as often as by the other; and I also find that exceptions are taken to my presentation of this subject in about even measure by the *doctrinaires* on the free trade and the *intolerants* on the protective side alike. I may perhaps characterize this essay as one "upon the protection of domestic industry, and the development of the home market by exemption from unnecessary taxation"; or, for short, I will call it "Common Sense applied to the Tariff Question."

The motive of this address may be given in the form of a simple account current, which might be entitled "Uncle Sam in Account Current with his People." We, his people, may rightly charge Uncle Sam with the contributions which we are called upon to make in order to meet the obligations of Government.

We may credit Uncle Sam with the expenditures that are required to meet the obligations of the war, and also for the conduct of the Government, equitably administered with the least interference with the freely chosen pursuits of the people:

This account is adjusted to the prospective revenue, predicated on receipts to date in the year 1890.

I will therefore make Uncle Sam debtor to the amount of the war taxes which are collected under the internal revenue system on whisky.....	$78,000,000
To the amount of the war taxes which are collected under the internal revenue system on fermented liquors.....	27,000,000
To the amount of the war taxes which are collected under the internal revenue system on tobacco.....	33,000,000
To the amount of the war taxes which are collected under the tariff on sugar and molasses.....	60,000,000
	$198,000,000
Add for elasticity in 1890 and 1891.....	2,000,000
	$200,000,000

REVENUE FROM WAR TAXES.

We will credit Uncle Sam with the annual obligation for the payment of pensions already granted, now rated at $65,000,000, adding for arrears $35,000,000.....	$100,000,000
We may now hope that the current annual pensions, aside from arrears, may not get beyond the sum named above, $65,000,000. It will be observed that the payment of arrears is the liquidation of a debt now in process of being audited, and that on payment the liquidation of arrears of pensions is final.	
We will credit Uncle Sam the amount of interest which must be paid on the war debt.....	31,500,000
	$131,500,000
We will credit Uncle Sam with the amount which should be applied to the sinking fund for the extinction of the war debt.....	48,500,000
	$180,000,000

When we balance these war taxes against the war expenses, we find a surplus which may be carried forward to meet the ordinary expenses of the Government, $20,000,000, and this surplus will be subject to rapid increase with the growth of population and the presently diminishing burden of debt and pensions.*

* Between the date of the preparation of this treatise in May, 1890, when it was written for submission to a private club, and the correction of the proof for publication, a Pension Act has been passed which may for a time take up this excess of war taxes above the previous war expenses, and even a little more. It is believed, however, from the best information that can be obtained, that even under this act the current annual pensions will not exceed $100,000,000 a year.

On the other hand, the elasticity of the revenue which is due to the growth of the population and progress of the country, will be likely to render the avails of the taxes on liquor, tobacco, and sugar quite sufficient to meet even the extravagant pension-list under this and previous acts, and the diminishing amount of interest on the public debt, even without stopping the contribution to the sinking-fund, or providing for it in any other way. In English practice, which we might well adopt, such an extravagant Pension Act as that which has now been added to our previous ample provision would have been accompanied by a proposed tax intended to meet it specifically, like an income-tax or a renewal of the duty on tea and coffee. Such is not our habit of legislation, although it well might be.

In the analysis which I shall present in this essay, I shall endeavor to prove how readily the remainder of the necessary contributions of the people to the support of the civil government may be collected wholly from taxes on articles of luxury or of voluntary use, or on the finer textiles which are dependent on style and fancy for their sale, without putting any tax of any kind upon any commodity, either partly manufactured, crude or raw material, which is necessary in the processes of our domestic industry. I shall endeavor to show how the removal of $40,000,000 to $50,000,000 of obnoxious taxes now imposed upon this class of materials may open the way to products, sales, wages, and profits amounting to at least $500,000,000 a year, which such a policy would add to the resources of this nation, to be divided equitably among the people in the form of additional wages and profits; thus promoting domestic industry, enlarging the home market, raising both the rate and the purchasing power of wages, and increasing profits.

In the renewed discussion of the tariff question it has become unpleasantly manifest that men are taking positions which may soon lead to a very bitter conflict, in which contest mutual recrimination will cause distrust and may prevent any suitable reform of the tariff being carried into effect, as it ought to be, by the common consent and governed by the common sense of all men who are directly interested in the matter, and by the application of that sound business judgment which should be applied to this business question.

It is very true that there are moral as well as political considerations underlying the whole problem of the tariff. Such being the case, it is a matter of duty for the citizen who will not be directly affected either in property or in person in any considerable measure by any changes in our tariff legislation, yet to watch it and to give it a true direction. The effect of tariff measures, considered from the money point of view in their burden or their benefit, has, I believe, been very much overrated; but the evil of dependence upon legislation in the conduct of industry can not be exaggerated.

In the way in which this subject of tariff reform is now being treated, whatever is done will be badly done; therefore, great harm

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In this connection, however, it may well be remembered that the interest on our public debt at its highest point amounted to more than $150,000,000. It is not probable that pensions and interest will exceed, if they equal, this sum. This great obligation for interest did not prove to be inconsistent with a large excess of revenue which has been so wisely applied to the reduction of our debt. The attempt to spend the public money in order to prevent the reduction of the tariff has probably culminated; but the increase of the obligation for pensions renders a scientific or common-sense treatment of the tariff question yet more necessary than it was before.

will ensue before any true adjustment of duties can be made to present conditions, although both political parties now agree that great changes are absolutely necessary. How can we separate this question from party politics?

It has always seemed to me very absurd, even grotesquely so, that men who are accustomed to put confidence in each other in the conduct of all their private affairs as well as in their town and city work; who trust each other in every walk of life; who serve together on boards of directors in savings banks, insurance companies, trust companies, and the like, and who adjust all differences of judgment in a reasonable manner, yet when this subject of tariff legislation comes up impute to each other, or else sustain newspapers that impute to each other, every form of insincerity, untruth, fraud, and malignant selfishness.

There is nothing so foolish as the imputations which are put upon the advocates of free trade by their opponents, except the corresponding imputations put by their opponents upon the mass of the advocates of protection, of lack of care or consideration for the public welfare. The masses are sincere on either side, however time serving and incapable their political representatives may be.

Conceive what the conditions of this country would be if the ideas which the Cobden Club represents had not prevailed, and if our wheat and dairy products were boycotted as our pork is in Germany; or if our cotton were taxed as it was before the markets of Great Britain were made free. In 1880 there were nearly eight million men occupied in agriculture; now there are ten million, more or less. In 1880 seventeen per cent of the product of agriculture found a home market only by sale for export; now about twelve per cent. If we did not exchange this product for other products, we could not sell it. If we could not sell it for export, over a million men would be driven from the field to the factory and to the workshop.

When I listen to the foolish talk of partisans on either side, and witness the ill-judged contention on the tariff question, I am sometimes inclined to exclaim, "A plague on both your houses!" Is it not time that this method of imputing wholly selfish or bad motives should cease, and that any one or every one who indulges in it should be held in contempt as an example of intellectual stupefaction?

It was well said by President Cleveland when he so bravely brought the subject to an issue, "What we have to deal with is a condition and not a theory."

Let us consider this condition, find out exactly what it is, and then see what we have to do in the matter, each man on his own account.

I have never known any intelligent advocate of a tariff for

protection who did not consider free trade as the ultimate objective point in all tariff legislation. I do not know any man of any intellectual standing, in public or in private life, who does not now look upon free trade as the true objective point of all tariff legislation. All sensible men hold that there are existing conditions which make it inconsistent with the public welfare to adopt revolutionary free-trade measures at the present time; but they all accept the fundamental principle, provided certain conditions precedent can be established in a safe and proper way.

The difference among intelligent men at the present time is only as to the time when it may be suitable to begin tariff reform in this direction, and upon the method of such reform. So it has always been. It is only the first step that costs. Gladstone once said, doubtless recalling his own experience and change of views, "The road to free trade is like the way to virtue, the first step the most painful, the last the most profitable."

The conditions which now obtain in this country correspond very closely to those which existed in Great Britain in 1842, at the time when Sir Robert Peel was compelled to modify and ultimately to change all his previous conceptions upon this subject, and to become the leader in the great reform of the British tariff which ended in the present system, sometimes called that of British free trade. This system is not free trade in an abstract or in an absolute sense, because Great Britain raises a large revenue from duties upon foreign imports, and will probably be compelled to do so for very many generations in order to sustain the burden of her great debt. We shall also be compelled to raise a large part of our revenue from duties upon imports, for one generation; but I will presently prove that our advantage in conditions is so great that it may enable us within even less than one generation to adopt absolute free trade if it shall become expedient to do so, except so far as it may continue to be necessary to tax the import of spirits in order to maintain the revenue derived from an excise measure. Whether or not absolute free trade may be desirable or expedient, it will be time enough to determine when the opportunity is offered. What we have to deal with now is our present condition and not this theory, as President Cleveland so well put it.

In one of Sir Robert Peel's great speeches which he made long after he had entered upon this course, he spoke as follows, in explanation of his course at the beginning of the reform of the tariff:

"I stated, and I am ready to repeat that statement, that if we had to deal with a new society in which those intricate and complicated interests which grow up under institutions like those in the midst of which we live, had found no existence, the true abstract principle would be to buy in the cheapest market and to sell

in the dearest. And yet it is quite clear that it would be utterly impossible to apply that principle in a state of society such as that in which we live, without a due consideration of the interests which have grown up under the protection of former laws. While contending for the justice of the abstract principle, we may at the same time admit the necessity of applying it partially; and I think the proper object is first of all to lay the foundation of good laws, to provide the way for gradual improvements, which may thus be introduced without giving a shock to existing interests. If you do give a shock to these interests, you create prejudices against the principles themselves, and only aggravate the distress. This is the principle on which we attempted to proceed in the preparation of the tariff."

Our present conditions correspond almost exactly to this statement; and the logic of events is bringing almost all economic students, many legislators, and also nearly all the intelligent leaders in the manufacturing and mechanic arts to the same conclusion to which Sir Robert Peel was brought by the logic of events when he took office in 1840; especially by the very disastrous condition to which Great Britain had been brought under an obstructive tariff policy the effect of which culminated at that date.

One may also refer to one of the greatest speeches that Daniel Webster ever made—a speech which he delivered at Faneuil Hall in October, 1820, at a meeting which had been called to resist an increase of duties above the very moderate revenue tariff of 1816, which was then in force—a meeting such as ought to be held now to protest against a worse measure. This meeting was called by men whose names are familiar to every Boston man—by William Gray, James Perkins, Nathan Appleton, Abbott Lawrence, Joseph Sewell, George Bond, Thomas Wigglesworth, William Sturgis, and by many others whose names have been household words among the merchants and manufacturers of Massachusetts for generations. In dealing with the high tariff measure, which was then being forced upon Massachusetts against her will, Webster said:

"To individuals this policy is as injurious as it is to government. A system of artificial government protection leads the people to too much reliance upon government. If left to their own choice of pursuits, they depend on their own skill and their own industry; but if government essentially affects their occupations by its systems of bounties and preferences, it is natural that when in distress they should call on the government for relief. Hence, a perpetual contest follows, carried on between the different interests of society. Agriculturists taxed to-day to sustain manufactures—commerce taxed to-morrow to sustain agriculture—and then impositions perhaps on both manufactures and agri-

culture to support commerce. And when government has exhausted its invention in these modes of legislation, it finds the result less favorable than the original and natural state and course of things. I can hardly conceive of anything worse than a policy which should place the great interests of this country in hostility to one another, a policy which should keep them in constant conflict, and bring them every year to fight their battles in the committee-rooms of the House of Representatives at Washington.

"An appeal has been made to the patriotic feelings of the nation. It has been said we are not independent so long as we receive these commodities from other nations. He could not see the force of this appeal. He did not perceive how the exchange of commodities between nations, when mutually and equally advantageous, rendered one dependent on the other, in any manner derogatory to its interest or dignity. A dependence of this sort exists everywhere, among individuals as well as nations. Indeed, the whole fabric of civilization, all the improvements which distinguish cultivated society from savage life, rest on a dependence of this kind. He thought the argument drawn from the necessity of providing means of defense in war had been pressed quite too far. It was enough that we had a capacity to produce such means when occasion should call. The reasoning assumes that in war no means of defense or annoyance can be probably obtained, or not without great difficulty, except from our own materials or manufactures. He doubted whether there was much ground for that assumption. Nations had hitherto obtained military means in the midst of war, from commerce. But, at any rate, as it was acknowledged on all hands that the country possessed the capacity of supplying itself whenever it saw fit to make the sacrifice; and he did not see why the necessity of making it should be anticipated; why should we now change our daily habits and occupations, with great loss and inconvenience, merely because it is possible that some change may hereafter become necessary? We should act equally wise, he thought, if we were to decide that although we are now quite well, and with very good appetites, yet as it was possible we might one day be sick, we would therefore now sell all our food and lay up physic."

In another part of this great speech Webster, with prophetic insight, foretold how the whole face of New England industry and society would be changed for the worse if this high tariff policy were forced into effect by sectional votes. Two generations have passed since Webster's prophetic words in Faneuil Hall in 1820. This speech was given just seventy years ago. Do we not now witness the representatives of different industries fighting their battles in the committee-rooms of the House of Representatives at Washington? Do we not to-day witness agriculture

taxed in order to sustain manufactures; commerce taxed to sustain agriculture; and impositions proposed upon both agriculture and manufactures to sustain commerce by subsidies and bounties?

Again quoting President Cleveland, "It is a condition and not a theory which we are called upon to meet." What is that condition? Here are two parties in Congress each attempting to deal with this great problem, each claiming to be equally in earnest to promote domestic industry, to develop the home market, and to protect the workmen of this country. The representatives of each of these two parties are elected by great bodies of voters who are equally honest and sincere in their efforts, or who have persuaded themselves that they are, and that the future prosperity of the country will depend upon their having their way. In this position we merely find conditions of the same kind that have been met before. In every great emergency each party claims to be the savior of the country; but the country saves itself in spite of parties, as it did in the civil war. Its material progress continues on its stupendous way in spite of the little petty obstructions which are interposed by those who believe they can manage all the affairs of the people better than they can manage them for themselves.

Between these two parties, if this is to be a party question, each one of us must make a choice when we vote or when we select the party with which we must act. Both these parties claim to protect domestic industry in the measures which they propose; but their proposed measures differ fundamentally. On the Republican side the policy is to tax every foreign product, crude, partly manufactured, or finished, of which a similar product has been or can be established in this country, without regard to the effect of such a tax on other branches of industry. Their avowed purpose is to impose taxes "for protection with incidental revenue," in order to render this country, as they term it, "independent of all others." It does not matter to them whether a branch of industry which might be set up exists at the present time or not. For instance, the Republican tariff bill will double the tax on tin plates without regard to the use to which these tin plates are to be put. No regard is paid to the nature of the work which must be done in order to ascertain whether it is desirable or not. The promoters of this measure simply say, Here is something which may be made in this country for which we now exchange our surplus products. The work ought to be done here, even if its establishment costs twice or thrice what it is worth!

Now, if the most superficial examination had been given to the kind of work which is to be done in dipping sheets of iron or steel into melted tin by hand, no machine having been invented for displacing this process, it would have been found that it is an art for which the people of Wales not only possess an inherited apti-

tude, but also that it is one which could not be established in this country without importing the Welshmen to do it, because we have so many opportunities for work, under more wholesome and profitable conditions, that we can not afford to do such work, no matter what the inducement may be.

In other words, the policy advocated by the Republican party is one of privation and not of protection, and it is avowedly sustained by many prominent Republicans against their avowed conviction of what would be beneficial, and merely because an assumed party necessity compels them to surrender their own convictions of right.

On the other side, the policy advocated by the Democratic party for protecting American industry is to exempt from taxation all articles of foreign origin which, either in a crude or in a partly manufactured state, are necessary or useful in the processes of domestic industry. They hold that our capacity to produce food which the world must have or suffer from hunger; cotton, without which the commerce of nations would be crippled; oil which we can not burn ourselves; goods, wares, tools, and implements of many varieties, the best of their kind; all our great crops made and all our goods being produced or manufactured at the highest rates of wages and yet at the lowest cost as compared with any other country in the world, enables us to exchange these products for the crude or partly manufactured materials, the raw wool, the tin plates, and for whatever we need which foreign laborers or workmen desire to sell in exchange. They hold that if we can get for one day's work at high wages in our own country the product of ten days' work even of foreign paupers, we can not afford to do that kind of work for ourselves; they hold that by such exchange we may gain yet higher wages and larger profits, the wider we can extend our commerce on such terms.

They hold that what we receive from other countries in exchange for the excess of our products which we can not consume, becomes as much a part of our own product as if these necessary commodities had been produced on our own soil or from our own mines and forests.

They hold that the home market is most fully established when all possible obstructions to the mutual service of nations are removed and the utmost facility given to the people of every land to send to our home market what we need and to buy in our home market what we do not want for our own use.

That is free trade, qualified by the necessity of obtaining a revenue from duties on selected imports. When we have attained it we may wonder why any one ever dreaded it; and if I may once more repeat my favorite quotation from Mr. Gladstone, "Then will the ships that pass between this land and that be like the shuttle of the loom, weaving the web of concord among the nations."

Between these two lines of policy every voter will soon be compelled to choose, and by making this choice a great change in the relative influence and importance of one party or the other will be brought about unless we can separate this question from party politics.

In order that this choice in each man's method of action may be rightly made, it now becomes expedient to treat the method of tariff reform simply as a business question and not as a party question. Parties which were thrown out of all true relation to the future by the issues of the past ought to be reorganized so as to carry into effect the conclusions to which voters have been brought by their convictions of right on the issues of the future. When they are renovated in this manner one may expect a great many men who are now holding prominent positions to be relegated to private life. Their places will be taken by men who are competent to apply reason, judgment, and common sense in their methods of fiscal legislation, a faculty or capacity which has been denied to many of those whom the circumstances of the past have thrown up into positions of considerable prominence which they have continued to hold up to the present time, but for which they are incapable.

When dealing with the tariff question in this way it is probable that every intelligent man who is conversant with affairs and who has given any attention to the reform of the tariff will agree wholly or very nearly with the following statement:

1. The present tariff is confused and inconsistent with itself in many of its provisions.

2. Some of its provisions which were especially intended to promote specific domestic manufactures have been either so erroneously framed or so construed in the Treasury Department as to discriminate against the very branches of industry which they were intended to promote.

3. These badly framed or badly administered provisions of the tariff acts promote undervaluation, evasions of duty, and fraud; but their worst effect is to discourage honest manufacturers and merchants alike by the uncertainty which they cause as to the future course of trade, as well as by the opportunities which they give both to dishonest employers, importers, and unscrupulous manufacturers to evade the laws.

I may venture to relate a little story of how tariffs are made and unmade. It is one of many incidents which made me a free-trader in principle.

I found an apparent inequality in the tariff act many years since, adversely affecting a branch of industry in which I had invested a few thousand dollars. I framed an amendment and sent it to a prominent Congressman from Massachusetts, who was on

the Committee of Ways and Means, explaining the reasons why it should be adopted. No hearings were given, and it seemed to be so fair, as I also thought it was, that it was adopted and went into the tariff with some other amendments. In it I used the technical word "hank." That Congress dissolved presently on the 4th of March. A few days later, the principal appraiser of the Boston Custom-House called upon me and put to me the question, "What is a hank?" I told him it was a skein of cotton yarn eight hundred and forty yards long; adding, "Why do you ask?" "Because," said he, "some damned fool has put a duty in the tariff by the hank, and, if we can't get around it, an established and important branch of domestic industry will be ruined." I asked for an explanation; and upon the development of the facts I said, "Well, you used the right term, and I am the man." Then said the appraiser, "You must see if there is no way to get around your amendment." I studied the matter carefully, and invented a way for avoiding or evading my own act. The threatened industry was saved, but I lost my little investment, as I deserved to, for putting my money into a business which I did not understand.

But this was not the end. Matters went on smoothly for two or three years, when there was a change of appraisers. The new man contested my construction of my own amendment, and undertook to enforce the law in accordance with the real intention. An appeal was taken to the Secretary of the Treasury. By good luck at that time I happened to call upon the collector; he, knowing my familiarity with the art but knowing nothing of my previous connection with the act, nominated me as merchant appraiser to decide the case on its merits. I of course sustained the practice of the first appraiser who had consulted me, and again the threatened industry was saved; by sustaining my own evasion of my own act, justice was done.

This is but one of many incidents which many men could relate; it is but an example of many great wrongs which have been done that have never been righted.

I have stated the conditions which render important changes in our tariff acts an absolute necessity. It is probable that all intelligent manufacturers and merchants, and all legislators except those who are bound by mere party ties in considering these changes, would agree upon the following propositions:

a. In the preparation of measures for collecting duties upon imports, such discrimination ought to be used as will most fully promote domestic industry and protect American labor from injury.

b. In framing such tariff measures, discrimination ought to be used so as to develop the home market for domestic products to the utmost; so far as this can be done by the exercise of judgment in framing tariff acts.

c. It is neither lawful nor expedient to impose duties upon imports without exercising such discrimination in the choice of subjects of taxation as will most fully promote the public interest, irrespective of private gain.

d. It is neither lawful nor expedient to frame measures for the collection of revenue from duties on imports for the purpose of raising or permanently maintaining the price of any given article above what it would otherwise be; except under the necessity of taxing such article for purposes of revenue only.

e. It is neither lawful nor expedient to put either a duty or a tax upon any crude or partly manufactured article which is necessary in the processes of domestic industry, by which large numbers of persons may be burdened, even if the interests of a lesser number might be for a time promoted.

If such are the conditions which we are now called upon to meet, and if such are the lines on which we are to work, then manifestly the first consideration must be given to sorting and classifying articles which are or may be imported, with a view to their use rather than with a view to the question whether or not they may be produced in this country. On the other hand, it must be admitted that there may have been some branches of industry which have been promoted by high duties and which may have been developed a little more rapidly than they would otherwise have been, under a high tariff, at the cost of the consumers for the time being. How shall they be treated?

It may be held that the position which has been assumed by most of the advocates of the protective system, I mean protectionists, according to the common acceptance of the meaning of that term, has been mainly due to the former misconception in regard to the source of wages, which was held even down to the time of Mill, and by him until a late period in his own life and work; to wit, a conception that wages are derived from a fund previously accumulated, and therefore from a "wage-fund" which might be to some extent under the control of capitalists by whom it should be administered, either in one direction or in another at their own choice. This mistaken conception of the source of wages leads to the further misconception that we must *make work*, or *provide work*, for a multitude, arbitrarily or willfully directing the force of capital in one way or another. What we really desire to do, what we really seek to attain, is that which is the purpose of all science and invention—not to make work, but to save work; to diminish the effort which is necessary to procure subsistence, shelter, and clothing, thereby increasing abundance. When we do that, it becomes necessary that there should be the widest possible and the freest possible exchange of services, or an exchange of product for product, of service for service, of product for serv-

ice, or of service for product, in order that those who are displaced from one kind of work by the application of science and invention may be most ready, able, and competent to take up some other kind of work less arduous, less exhausting, and more conducive to human welfare.

What is the object of exchange? How few people ever ask themselves that question! If each one of us did not save himself by exchange from some part of the necessary work required to sustain life, there would be no exchange; each one of us, and every other man, would live and work for himself alone. All this is elementary. It becomes perfectly clear when considered as between man and man. Does not the same rule govern the commerce of nations? What is the commerce of nations, except the sum of the exchanges between man and man? Unless each nation gains by the exchange, does not the trade stop? If both gain by the exchange, does it not hurt both to stop it by legislation? By obstructing exchange, we may make work where we might save it; but that nation loses most from such obstructions in which the greatest abundance of product is attained at the least cost of labor and at the highest rates of wages. If there were such a thing in the world as pauper labor, that nation which exchanged the greatest amount of the product of skilled labor for the greatest amount of the product of pauper labor would save itself the most work. Daniel Webster once said, when in his prime, "The people of this country can not afford to do for themselves what they can hire foreign paupers to do as well for them." This is true not only in respect to the price of labor, but to the kind and quality of the work which is to be done.

There are many branches of industry from which science has not yet removed the noxious or bad conditions of the work. Dipping sheets of iron or steel which have been treated with acid into melted tin for conversion into tin plates is one of the arts which it would be most undesirable to introduce into this country until, by way of science and invention, its noxious conditions have been removed: then it will come here itself; the conditions will then be equalized; we can then afford to take up what it would now be injudicious for us to undertake.

When we consider the obstructive and injurious effect of many of our taxes, light although they may be in money, we find that they are a heavier burden than those of almost any other nation except Russia, Turkey, and Spain.

They have not increased the profits in the arts which were intended to be promoted by their imposition, except for short or variable periods; they have reduced wages in the protected branches of industry below those which are attained in occupations which can not be subjected to foreign competition, while

they have kept the prices of most important materials, which are necessary in the processes of domestic industry, far above those of our competitors, promoting their prosperity and retarding our own progress.

Yet our enormous advantages in most of the conditions which are conducive to human welfare are such that we thrive. Our bad methods of taxation are like a pebble in the shoe of a runner, keeping him painfully in the second place, when, if relieved, he could lead the field without an effort.

It is due to these favorable conditions that the paradoxical form of statement represents an absolute truth—viz., that our high rates of wages are due to our very low cost of general production.

This leads us directly to the consideration of the conditions of production, especially in the manufacturing arts, from which our ample profits or high wages are or may be derived, if our moderate taxes are rightly adjusted to our conditions. We possess so great an advantage in our position and in our control of the production of metals, of fibers, and of food products, that there can, of course, be no equalization of wages in this country with those of others, because we could only equalize by reducing our own. The tendency of all the forces in action, when not artificially obstructed, is to raise the rate of wages, to diminish the margin of profits, and to equalize the conditions of working people to their great advantage. If we must wait for the equalization of wages to those of other countries, as is so often urged, before undertaking tariff reform, we may wait forever. It is our very advantage in high rates of wages and low cost of production which might enable us to proceed earnestly, safely, and surely to absolute free trade within less than a generation, and to adopt that policy for the very purpose, not of equalizing, but of maintaining our huge advantage over every other nation.

One may sometimes feel humiliated when one sees men of skill, capital, and ability trembling before the competition of what they call pauper labor. Every man of affairs, every manufacturer, every employer of labor, avoids low-priced or pauper labor in his own work as much as possible; he knows that it is costly; he knows that, when he can command skilled labor at the highest price which is warranted by the market for the product, he will do his work with that kind of labor at the least cost. When it becomes necessary to run works on short time and to discharge a part of the workmen, who are the ones discharged? Not the high-priced men; they can not be spared; it is the high-priced men whose work is not affected by hard times. Every man makes his own rate of wages by his skill, aptitude, and industry; and those who do the work in the best manner get constant employment. The incapable are sometimes subject to compulsory idle-

ness. In the factories I have known cases where all the looms were watched, and every weaver who did not reach a certain standard in her earnings was discharged because the mill could not afford to have poor weavers employed in it.

Yet, although we possess so many advantages within the limits of our own domain, there are some parts of the world which hold an advantage over us, especially in the production of some of the crude materials which are necessary in the processes of domestic industry. There are also many arts from which science has not yet removed the noxious conditions or the excessive labor. These arts we had better not undertake so long as we can buy their product with the excess of our crops of grain and cotton.

Again, there are some sections of this country which could be more adequately supplied with crude materials from Canada than they can be from Pennsylvania; New England, for instance, in respect to iron and coal. Our members of Congress sustain the policy which deprives us of the vast deposits of iron, coal, and even of other materials, which are lying unused in the Maritime Provinces. They tax the wool of Australia and South America; they propose to double the tax on tin plates; and they endeavor to promote the manufacture of burlaps and other coarse fabrics made of jute within our own limits.

The question of crude materials I have treated. The noxious conditions under which tin plates are made, I have referred to. The making of burlaps as it is now conducted in Dundee is one of the least desirable occupations that human beings can be called upon to follow; until it has been improved, we had better buy our burlaps with cotton than try to make them ourselves.

Even the finest fabrics which are suitable for taxation for revenue, such as Brussels laces and the like, are made by hand at the lowest wages and under the most abject conditions of life. The finest silks must be woven by hand, because the silk-worm does not spin his thread so evenly as to make it possible to weave it on the positive power-loom. In fact, in respect to many of these finer articles, which are perfectly suitable subjects for a tariff for revenue rather than for protection, there are elements to which no attention has been given; they specialize themselves even according to heredity or to peculiar conditions. The finest cotton yarns are spun in England, sent to France to be woven, sometimes transferred to Germany to be dyed; and brought back to England to be sold. Some of the finest linens are made by growing the flax in one place, spinning it in another, and weaving it in another, all far apart. We can not force the manufacture of flax in this country until we have a great surplus of population which shall be compelled to do the work which the Irish, the Belgians, and the French are now forced to do for us even at the lowest

wages. The preparation of the fine flax by rotting is noxious, and can only be worked at the lowest possible rates of wages paid for mere manual labor. We can better afford to raise flax for the seed and burn the stalks rather than to force American labor into un-American lines of work, in the preparation of the fiber by the existing noxious methods.

All these matters must be considered, and when considered they prove how futile, how impossible it is for a Congress composed of men who have little or no knowledge of the practical affairs of life, to attempt to regulate prices and wages, directly or indirectly, by the enactment of revenue acts.

I have named several articles which are necessary in the processes of our domestic industry, in which some other countries possess an advantage over us, such as tin plates, burlaps, and the treatment of flax. These advantages exist especially in respect to crude materials to which machinery has not yet been applied to any great extent; and of manufacturing processes in which the greater part of the work is done by hand. In hand-work the rate of wages may be, and often is, a fair standard of the cost of production. Hand-work here and elsewhere is that which earns least and can not be protected by any system of taxation of any kind.

We annually import, free of duty, $120,000,000 worth of articles of food, and $140,000,000 worth of crude or partly manufactured articles which are made use of in our domestic manufactures, because we can not yet afford to do the work which would be required in the production of these articles, since our own workmen can do so much better than to undertake the kind of work required.

But we also annually import, aside from sugar and molasses, $40,000,000 worth of the most necessary articles of food; and $130,000,000 worth of articles in a crude or partly manufactured condition which are absolutely necessary in the processes of our domestic industry, on which we impose duties or taxes amounting to about $50,000,000 a year. To that extent our workmen are placed at a disadvantage as compared with the workmen of other manufacturing countries in which most of these articles are admitted free.

The saving of this tax of about $50,000,000 a year would be but a very small matter were it not for the effect of this tax on foreign imports on the prices of many domestic products. Out of the $50,000,000 a year which has been collected on crude materials, about $4,000,000 has been gained to the Government from duties on iron ore and pig iron. An addition of twenty-five cents on each barrel of beer now produced would yield the same amount of revenue. If it were assessed upon the beer, the entire tax that the people pay would be secured by the Government, and the exact cost would be $4,000,000 revenue, with three per cent for the cost of collection by means of stamps.

Now, what has been the effect of the tax of $4,000,000 on the price of iron and steel in this country? Various computations have been made, the latest by Mr. A. B. Farquhar, of York, Pa., the largest exporter of agricultural machinery in this country, and perhaps one of the largest manufacturers of agricultural machinery in the world. He computes the actual difference in cost of iron and steel to the consumers in this country during the last ten years at about $700,000,000 or $70,000,000 a year. David A. Wells, making very large corrections for contingencies, estimates the difference in the cost of these metals to the consumers of this country, as compared to the consumers of Great Britain, at $560,000,000 for ten years, giving a little different period of time. My own computations, which have been made with the utmost care and which are based wholly upon the figures given by the Iron and Steel Association of this country, and of the Iron and Steel Institute of Great Britain, make the excess of price paid for iron and steel in this country as compared to others, in the years 1880 to 1889 inclusive, not less than $500,000,000 and probably $800,000,000. I may add that the effect of the tariff upon iron and steel has been much greater than in respect to other articles. This country now consumes thirty-five to forty per cent of the entire product of iron made in the civilized world. Our consumption at the present time is greater than the largest product of Great Britain in any year. No other country could possibly supply us. No other country could have supplied us for many years. But by the partial obstruction to our demand upon Great Britain and Germany, due to our own tariff, the price of iron and steel in Europe has been very greatly depressed. The tendency throughout the world has been to a rapid reduction both in cost and in the price of these metals, due to the application of revolutionary inventions. But the reduction in price in gold has been much greater in Great Britain than it has been in this country: consequently, by our own act we have protected the ship-builders, the machinists, and the tool-makers of other countries, while preventing the extension of these arts in our own country; even failing to retain our home market.

We import a considerable proportion of the products of iron and steel that we consume, sometimes in the form of railway-bars, yet more in the form of hardware, tools, and machinery. A first-class textile factory can not be equipped in this country without resort to the machine-shops of Great Britain for a very considerable part of the most necessary machinery.

Again, the burden of a tax upon crude materials is to be gauged, not by its ratio to the value of the product into which it might enter and does enter as a component material, but in ratio both to wages and profits in the arts in which it is needed. If we

artificially raise the cost of materials and are unable to control the price of the product into which these materials enter, then it often happens that we must keep the wages down in corresponding measure, or else give up the undertaking; and, again, a yet more subtle difficulty: if we can not make a profit over and above the cost of materials, the wages, and the general expenses, then no capital will be invested in that branch of industry, and no wages can be paid, for lack of profit.

Now, observe how subtle this matter is. Any conspicuous or important branch of industry which will pay ten per cent profit will attract capital and will be established; but if the tax on the crude material is even ten per cent upon the finished product, and this tax can not be paid without doing away with the profit, then that art stops, and the other ninety per cent which would be distributed among the workmen is lost to them, merely because there is a disadvantage of ten per cent in the cost of the material as compared to some other places.

Now, then, any one who is conversant with the complexity of all modern manufactures can not fail to be aware that the revenue which the Government derives of $50,000,000 on the crude or partly manufactured materials which we do import and which we do use in the processes of our domestic industry, may so much restrict that industry by increasing our own cost of production as to limit our home market both for domestic and foreign traffic, and may prevent the establishment of arts in which ten times as much, or $500,000,000, might be distributed among those who would do the work if these articles were free from taxation.

This is the consequence of the higher price of domestic products in this country or the lower price which prevails abroad for lack of competition.

The very worst effect of a duty on crude materials ensues when, according to its advocates, it is most successful. They hold that if, by our tax, the price is put down in a foreign country, then the foreigner pays the tax. There are no words suitable to apply to such folly. By that very depression in the price of pig iron and wool we have built up the manufactures and machine-shops of Europe, and have failed more and more to hold our home market even for the specific products of the loom and the forge.

Moreover, the price of some of the most necessary articles of our domestic products which enter into our domestic industry, notably iron and steel, are maintained far above what the price would be except for this system of taxation, although not, perhaps, to the full measure of the rate of duty which is assessed. Hence it follows that, owing to this higher price on the most necessary articles of consumption in the manufacturing and me-

chanic arts, we have been unable even to retain our home market for domestic manufactures, and have been cut off from any considerable share in the supply of other countries.

In a rough and ready way, it may be said that the cost of materials, in all the staple products of machinery or in manufactured goods, ranges from one half to three quarters the entire cost of the finished product. If the price of these materials is kept even ten per cent higher in this country than it is in others, then of course all profit may be cut off by that disparity, and, in spite of vain attempts to put on compensating duties, that art languishes, and we protect the foreigner rather than the American.

It will be remembered that no heavy stocks of food, fiber, or fabrics are now carried anywhere in the world, beyond the probable consumption of a single year or less. Hence it follows that, in respect to the import of materials which enter into the processes of our own work, whatever the price may be in any given year, whether high or low, if through our high tariff the consumers are subjected to a higher price than our competitors abroad, our industry languishes and foreign industry is protected.

I have said that there are two parties, each earnestly claiming to promote domestic industry. On the one side we find the Republican party advocating privation of foreign imports, without regard to the uses for which such articles are required, in order to protect the few specific branches of industry in which we do not yet excel other nations. On the other side we find the Democratic party advocating the protection of the domestic industry of all alike, by exempting from taxation every article which is necessary in the processes of domestic industry that we can procure in any other country in exchange for the excess of our cotton, corn, wheat, and other commodities, which, even at the highest wages obtained anywhere in the world, are yet produced at the lowest cost.

Such is the position of the question on which every voter will be called to decide in exerting his influence and in choosing whom he will support.

Such were the exact conditions in Great Britain in 1840, only worse, because the natural resources of Great Britain, both in respect to agriculture and mining, are so much less than our own.

The first measures of relief from taxation in Great Britain were practically instituted by Huskisson in 1824, when wool and some other crude materials were in part or wholly relieved from duties. The effect of this change, especially upon the product of domestic wool in Great Britain, was very beneficial; relief from duty gave the manufacturers of Great Britain the opportunity to buy all the wool which they would require for any kind of work, and the consequence was, that the demand for British wool in-

creased, and did not diminish, as the farmers feared. These measures of Huskisson, however, were purely tentative; and, subsequent to 1824, there was a great financial struggle in the process of restoring specie payment in the Bank of England, and in the bringing about conditions consistent with peace. The great Napoleonic wars in the early part of the century had thrown every art and industry out of its true relation. But the method of reform was not forced upon the attention of the people of Great Britain until the disastrous results of the attempt to regulate prices and wages by way of a high tariff, and the failure of this method of promoting domestic industry and of developing a home market had culminated in 1840.

In every history of this time, the picture of the condition of Great Britain is one of the most painful suffering on the part of most of the working people. The land was held in the hands of a very few great landholders who were protected by the corn laws, and who were thus enabled to charge high prices for necessary food. Great wealth had been accumulating during the period of war in the development of mines, works, and factories. Individual wealth existed in a measure never before witnessed; and this condition misled many legislators in this country; it deceived the very elect, and doubtless led Henry Clay and other champions of a high tariff to advocate the very policy which Great Britain was then being forced to give up by the disastrous results which had ensued. Underneath this outside show of prosperity, poverty, destitution, and want existed on every side; pauperism existed as never before or since among any English-speaking people.

At the time when Sir Robert Peel took office in 1840 it was clearly proved that the very measures which had been enacted for the purpose of establishing a home market and building up domestic manufactures "had destroyed that market by reducing the great mass of the population to beggary, destitution, and want." I quote the exact words of a contemporary observer.

Those who choose to discriminate between the leaders of the two parties of the present time may read the perversion of English history by James G. Blaine, in the North American Review; and the true picture which is given by General M. M. Trumbull.

It would be well worth while for any one who may have been misled by the common errors about the influences which brought Great Britain to reverse her policy in 1842, to read up the economic history of that period. It can be done in a very few days. All the facts are given by the radical Miss Martineau in her History of Fifty Years' Peace; by the Tory, Sir Stafford Northcote, in his Twenty Years' Financial Policy, explaining the changes which Peel brought about; by the economist John Noble's Fiscal Legislation in Great Britain; or in Carlyle's

Past and Present. The best summary is to be found in the little book published in Chicago in 1884, by General M. M. Trumbull, entitled The American Lesson of the Free Trade Struggle in England. In this book will be found the whole record of the condition of England from 1838 to 1846, after the panic of 1836 which originated in this country and spread to Great Britain had spent its force, down to the culmination in 1846 of the measures which Peel instituted but which were substantially completed by Gladstone in 1853. This history ought to be read by every man who desires to make up his mind how to act in this country at the present time. The logic of events is the same. We are repeating history. We are suffering, so far as it is in the power of legislators to stop the progress of this country, from injudicious methods of obstruction; and we may make progress in agriculture and in manufactures by "great leaps and bounds," as Gladstone put it, whenever we choose to adopt the policy which will soon be brought into action, whether we will or no, by the logic of necessity.

The basis of Peel's tariff reform in England was established by Joseph Hume, who, being appointed chairman of the committee in the House of Parliament, made a report on the tariff of Great Britain, which then covered about twelve hundred and fifty specific articles, at an average rate of about twenty-eight per cent on dutiable imports. In this report he first sorted imports, according to their use, under four heads:

Crude materials.

Partly manufactured materials.

Manufactured goods.

Articles of the nature of a luxury, like wines and tobacco.

It was a case of condition and not of theory which Sir Robert Peel was called upon to meet when he took office. He met that condition by discriminating in choosing the subjects of taxation in the tariff which he presented, placing in the free list all the little petty taxes or duties on which an agreement was readily made, and then either making free partly manufactured goods or greatly abating duties upon them, at the same time reducing the duties on finished products except those of the fourth class, viz., those of the nature of a luxury or voluntary use.

I had become so much impressed and influenced by the success of this method that, during the last few months of the administration of Secretary Hugh McCulloch, I suggested to him to class the imports of this country in a way corresponding to Hume's method. I gave him my reasons somewhat in this way, that in whatever manner, by whatever party, under whatever name the reform of our tariff should at a future day be taken up, it would of necessity be governed by the logic of the lines or classes on which these imports might then be sorted. The suggestion was

adopted. I made five classes; and since that date the fiscal statement of each year has been tabulated in that way.

I venture to incorporate at this point the statement of the imports under each of the heads named with the duties thereon. I take these figures from the last report of the Bureau of Statistics of the Treasurer of the United States for the fiscal year ending June 30, 1889.

IMPORTS ENTERED FOR CONSUMPTION.

Imports of Merchandise subdivided into Groups or Classes according to Degree of Manufacture and Uses.

In the following tables the extended classification for imports entered for consumption, embracing over a thousand articles and classes of articles, which is mainly an alphabetical arrangement with two grand subdivisions of free and dutiable articles, has been subdivided into the five following general groups or classes, according to the degree of manufacture and uses of the articles imported. It is hoped that the condensation of imports into these groups will in some measure aid and simplify the labors of those engaged in investigating the operations of our tariff laws.

For more extended explanation of this classification, see report of this office on Imported Merchandise entered for Consumption, 1887, page xxiv, etc.

CLASS A.—*Articles of food, and animals.*
CLASS B.—*Articles in a crude condition which enter into various processes of domestic industry.*
CLASS C.—*Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts.*
CLASS D.—*Manufactured articles, ready for consumption.*
CLASS E.—*Articles of voluntary use, luxuries, etc.*

The value of imported merchandise entered for consumption in the United States, with the amount of duty collected thereon added, for the year ending June 30, 1889, has been as follows:

CLASSES.	Values.	Per cent of total value.	Duty collected.	Per cent of total duty.	Total value and duty.
(A) Articles of food, and animals	$240,666,693	32·45	$66,568,932	30·44	$307,235,625
(B) Articles in a crude condition which enter into the various processes of domestic industry	172,134,716	23·22	15,363,625	7·02	187,498,341
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts	84,354,509	11·38	22,195,095	10·15	106,549,604
(D) Articles manufactured, ready for consumption	147,596,641	19·91	68,683,765	31·40	216,280,406
(E) Articles of voluntary use, luxuries, etc.	96,678,889	13·04	45,890,357	20·99	142,569,196
Total	$741,431,398	100·00	$218,701,774	100·00	$960,133,172

This table does not show the cost of the imports landed in our ports. There are not included in the values of articles the cost of coverings, commissions, etc., excluded from the dutiable value by the act of March 3, 1883; nor freight charges from the country of importation, and undervaluations, the aggregate amount of which can not be estimated with any approximation to accuracy.

Imports entered for Consumption during the Year ending June 30, 1889, with accompanying Diagram, showing the Relative Values of the Respective Classes of Free and Dutiable Imports, and the Relation of the Duty collected on each Class to its Value.

CLASSES.	Value.	Per cent of total.	Diagram. [Scale: 1 inch = $100,000,000.]
Free of duty.			
(A) Articles of food, and animals	$119,408,491	46·54	
(B) Articles in a crude condition which enter into the various processes of domestic industry	110,706,883	43·15	
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts	12,494,105	4·87	
(D) Articles manufactured, ready for consumption	9,820,801	3·83	
(E) Articles of voluntary use, luxuries, etc.	4,149,350	1·61	
Total	$256,574,630	100·00	
Dutiable.			
(A) Articles of food, and animals	$121,263,202	25·01	
(B) Articles in a crude condition which enter into the various processes of domestic industry	61,427,883	12·67	
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts	71,860,404	14·82	
(D) Articles manufactured ready for consumption	137,775,840	28·42	
(E) Articles of voluntary use, luxuries, etc.	92,529,489	19·08	
Total	$484,856,763	100·00	
Dutiable.	Duty collected.		
(A) Articles of food, and animals	$66,568,962	30·44	
(B) Articles in a crude condition which enter into the various processes of domestic industry	15,363,625	7·02	
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts	22,195,095	10·15	
(D) Articles manufactured, ready for consumption	68,683,765	31·40	
(E) Articles of voluntary use, luxuries, etc.	45,890,357	20·99	
Total	$218,701,774	100·00	

Summary of Values of Imported Merchandise entered for Consumption, by Groups, according to Degree of Manufactures and Uses, from 1880 to 1889.

	Year ending June 30—	VALUE OF—		Total.	Duty.	Ad valorem rate on dutiable.	Per cent of total duty.	Per cent of total value.
		Free of duty.	Dutiable.					
						Per cent.	Per cent.	Per cent.
(A) Articles of food, and animals.	1880	$90,637,062	$108,528,901	$199,165,963	$52,805,551	48·19	28·67	31·72
	1881	90,872,067	125,984,270	216,856,337	58,748,703	46·63	30·85	33·25
	1882	82,244,561	147,876,926	230,121,507	63,325,109	42·82	29·37	32·13
	1883	78,565,246	135,884,124	214,399,370	56,556,183	43·11	27·98	30·59
	1884	92,589,286	132,136,969	224,726,255	59,135,172	44·75	31·15	33·66
	1885	86,559,991	107,706,369	194,266,360	61,695,247	57·28	34·75	33·52
	1886	83,752,308	112,458,925	196,206,228	61,064,714	54·87	32·42	31·38
	1887	99,183,773	112,273,076	211,456,849	67,998,334	60·57	32·07	30·94
	1888	104,291,336	115,114,040	219,395,376	64,398,790	56·00	30·16	30·80
	1889	119,403,491	121,263,202	240,666,693	66,568,932	54·90	30·44	32·45
(B) Articles in a crude condit'n which enter into the various processes of domestic industry.	1880	96,980,615	63,075,261	160,055,876	20,650,128	32·74	11·32	25·52
	1881	92,570,041	56,929,006	149,499,047	17,130,700	30·09	8·85	22·98
	1882	103,045,047	61,010,729	164,055,776	18,788,424	30·80	8·71	22·91
	1883	102,844,608	46,321,172	149,165,775	12,936,129	27·93	6·17	21·29
	1884	94,039,567	44,457,174	138,496,741	11,922,748	26·82	6·28	20·75
	1885	82,507,747	37,101,595	119,609,342	9,454,989	25·48	5·33	20·64
	1886	102,438,364	41,613,658	144,059,022	12,563,115	30·91	6·83	23·04
	1887	106,389,082	59,542,660	165,931,692	19,567,908	32·86	9·23	24·28
	1888	111,808,141	56,221,508	168,029,649	15,580,839	28·16	7·42	23·59
	1889	110,706,883	61,427,883	172,134,716	15,363,625	25·01	7·02	23·22
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts.	1880	10,529,186	62,657,777	73,186,963	18,564,498	30·11	10·34	11·66
	1881	9,360,989	58,711,565	68,072,504	17,475,342	29·76	9·68	10·46
	1882	13,488,950	65,736,906	79,225,856	19,948,558	30·35	9·25	11·06
	1883	18,082,614	75,580,521	88,613,135	23,055,271	30·50	11·00	12·64
	1884	12,186,427	69,963,939	82,150,366	18,586,278	26·49	9·76	12·31
	1885	11,185,487	61,271,465	72,456,952	17,088,148	27·89	9·64	12·50
	1886	10,689,156	67,855,317	78,544,473	20,115,152	29·68	10·68	12·56
	1887	12,149,883	67,505,441	79,655,324	20,898,498	30·21	9·62	11·66
	1888	11,692,617	73,018,645	84,706,262	21,824,738	29·89	10·22	11·90
	1889	12,494,105	71,860,404	84,354,509	22,195,095	30·89	10·15	11·33
(D) Articles manufactured, ready for consumption.	1880	9,151,858	120,872,785	130,004,643	56,271,500	46·55	30·85	20·72
	1881	9,184,263	135,095,640	144,229,903	63,665,234	47·13	33·89	22·17
	1882	10,621,288	147,545,470	158,166,708	70,541,612	47·81	32·72	22·08
	1883	11,116,812	151,292,076	162,408,888	71,116,388	47·01	33·92	23·17
	1884	11,035,112	123,015,766	134,050,878	58,518,730	47·57	30·92	20·68
	1885	10,617,405	108,410,164	119,027,569	52,387,336	48·28	29·54	20·54
	1886	12,446,211	113,824,644	126,270,855	55,658,558	48·90	29·54	20·19
	1887	11,565,665	124,473,106	136,038,771	61,898,366	49·73	29·19	19·90
	1888	11,488,013	133,352,873	144,790,885	67,426,549	50·56	31·58	20·33
	1889	9,820,801	137,775,840	147,596,641	86,688,765	49·85	31·40	19·91
(E) Articles of voluntary use, luxuries, etc.	1880	770,459	64,371,367	65,141,826	34,328,490	53·32	18·32	10·88
	1881	1,129,102	71,341,106	72,461,208	36,541,032	51·22	18·88	11·14
	1882	1,322,164	83,321,935	84,644,099	43,018,978	51·63	19·95	11·82
	1883	1,354,014	84,888,491	86,242,505	43,995,728	51·83	20 98	12·81
	1884	1,429,873	86,721,276	88,151,149	41,732,067	48·12	21·98	13·20
	1885	2,041,604	72,178,227	74,219,831	36,698,580	50·84	20·69	12·81
	1886	2,204,725	78,030,511	80,235,236	38,682,583	49·58	20·53	12·83
	1887	3,805,306	86,581,089	90,336,345	42,174,328	48·74	19·89	13·22
	1888	4,874,746	90,451,708	95,326,454	44,063,886	48·70	20·63	13·88
	1889	4,149,350	92,529,489	96,678,839	45,890,357	49·60	20·99	13·04
Total.....	1880	208,049,180	419,506,091	627,555,271	182,415,162	43·48	.....	.....
	1881	202,557,412	448,061,587	650,618,999	198,561,011	43·20	.....	.....
	1882	210,721,980	505,491,966	716,213,946	215,617,671	42·66	.....	.....
	1883	206,918,289	493,916,384	700,829,673	209,659,699	42·45	.....	.....
	1884	211,280,265	456,295,124	667,575,389	189,844,995	41·61	.....	.....
	1885	192,912,234	386,667,820	579,580,054	177,319,550	45·86	.....	.....
	1886	211,530,759	413,773,055	625,303,814	188,379,397	45·55	.....	.....
	1887	233,093,659	450,325,322	683,418,981	212,039,424	47·10	.....	.....
	1888	244,104,852	468,148,774	712,248,626	213,500,902	45·63	.....	.....
	1889	256,574,630	484,856,768	741,431,398	218,701,774	45·18	.....	.....

Early in the administration of President Cleveland I ventured to suggest to Assistant Secretary Fairchild to carry back this classification from the year 1884, in which it was first established, to the year 1880, so that we now have the result of ten consecutive years, 1880 to 1889 inclusive, which I now submit for consideration. I think all will agree with me that no committee of any party or under any name can fail to be governed by the logic of these lines in preparing measures of tariff reform.

SANITARY WORK IN GREAT DISASTERS.

By G. G. GROFF, M. D., LL. D.,
PRESIDENT OF THE PENNSYLVANIA STATE BOARD OF HEALTH.

THE suggestions offered in this paper are derived from the experience of the past summer at Johnstown, Pa., and in the other flooded regions of the State, where a large share of the organization of the sanitary measures fell to the writer. Although one ninth of the inhabitants of the devastated district perished and were buried in the *débris*, along with thousands of domestic animals; and although typhoid fever, measles, and diphtheria existed in the district before the calamity, they never spread to any great extent, and certainly never became epidemic.

The region was a peculiarly difficult one in which to conduct sanitary relief. Along a narrow mountain valley for twenty miles were scattered some twenty-eight towns and villages, forming Johnstown. Of these, twenty were devastated by the flood, which left almost every village isolated from the others, all bridges and roads being destroyed, as also all horses and vehicles of the inhabitants, thus rendering communication extremely difficult or impossible. The members of the State Board of Health were unacquainted with the geography of the region, and with the local physicians, as well as with those who volunteered their services. There were no disinfectants on hand, and the whole appropriation of the Board for sanitary purposes was but two thousand dollars for the whole year. When, therefore, on June 1, 1889, representatives of the State Board of Health of Pennsylvania reached the desolated Conemaugh Valley, to do what could be done to prevent the occurrence and spread of disease among the exhausted and stricken survivors, the best estimates that could be hastily secured showed that ten thousand human beings, one thousand horses, one thousand cows, together with a great number of hogs, dogs, chickens, cats, etc., were drowned and buried in the *débris* at Johnstown, and in the drift-piles down the river, while ten thousand sufferers were without shelter, wet, hungry, and distracted. There were slime, mud, carcasses of domestic animals, and human bodies everywhere.

"No pen has yet fully described the condition that existed the next day after the waters of the South Fork Lake had swept the valley. The pen will never picture the desolation that existed, or tell of the difficulties that confronted the inhabitants of the stricken valley. The homes that were not swept away were left in the most unsanitary condition imaginable. The flood in many localities reached a height of thirty feet. This water contained

or was heavily laden with *débris* and every kind of filth, and whatever this water touched it contaminated. As a result, every house in the flooded district was filled to the second floor, in most cases, with offensive matter. In many cases dead animals were found in parlors, and scores of dead horses were removed from dwellings and business stands. Everything was covered with mud. There was not a place where the flood touched that man could lay his head with safety."

The State work began June 1st and ended October 12th. The result at Kernville, a ward of Johnstown, is a truthful index for the whole district. "With the concentration of twenty-five hundred people in three hundred and eighty houses, all subjected to intense mental strain by reason of the calamity and the radical changes in their habits of living, it is very gratifying to know that during the continuance of the Board's operations not a case of infectious disease developed in the district which should be attributed to bad sanitary condition." In the past history of national disasters we do not read of such gratifying results, but dire pestilence has too often followed great earthquakes, floods, fires, famine, and the disasters of war.

There are several measures not strictly sanitary, but most necessary, to which the sanitarian should give heed before his own special work occupies his attention. If the officers of the district have been lost, or in any way rendered inefficient, a strong government must be at once organized, and the district placed under efficient police control, that lawlessness and anarchy do not prevail. At Johnstown the people named a "dictator," who decided all questions of government and kept the region in order. The distress which lawlessness produces must not be tolerated. The organization of relief corps to succor the injured and dying, and to organize temporary hospitals, should receive next the attention of the sanitarian. So soon as the government is assured, and temporary relief is progressing satisfactorily, he may advise the proper committee as to what will be needed in the way of food, clothing, shelter, and medical stores. These will be required in large quantities; but in the United States, at least, we can safely rely upon the country at large to supply these things promptly. For shelter, tents can be had from the State Governors by applying to them.

At Johnstown the people did not like tents, preferring any kind of houses, and suffered great inconvenience from overcrowding rather than go into the tents. There were two forms of ready-made houses used—one, familiarly known as "Oklahomas," were of two sizes: the smaller, eighteen by ten feet, with one room, and a larger, eighteen by twenty-four feet, with two rooms; and the Hughes house, which was larger and better built, consisting of

four rooms. When tents or temporary houses arrive, the proper location of these should be decided by the sanitary officer in charge. These preliminaries having received attention, the work proper of the sanitary officer begins:

1. The supply of disinfectants should be ordered at once. This order should cover all that will be needed while the emergency lasts, and is necessarily larger in summer than in winter. It was found at Johnstown that the moral effect of a large supply of disinfectants was very great and for good. In ordering disinfectants it is well to provide that what is not needed may be returned to the manufacturers. Pure chemicals and those easy of application are the best.

2. The region should be divided into convenient districts, and each placed under a local physician as sanitary inspector. At Johnstown the local physicians named one of their own number as health officer, and he nominated to the State Board of Health the inspectors, and this plan worked very well. Inspectors are also needed for the camps of citizens and laborers, for the morgues and burial-places. These inspectors should all make a daily report in writing, stating the exact sanitary condition of their districts, and in these reports they should also state any need of food, clothing, shelter, or medical stores. So long as is necessary, the inspectors should give their whole time to their duties.

3. The burial of the dead needs early attention. In summer, this must be hastened if the number be very large; in winter, more time for identification can be given. If the number of dead is very large, and the distress of the survivors too great to permit of accurate identification, bodies should be buried in their clothes, so that identification can be made out at some future time, when the bodies may be lifted for reburial. Very careful and accurate descriptions of the bodies should always be taken before burial. If possible, the bodies should be brought to one point for identification. At Johnstown, for ten days, a large proportion of the bodies were embalmed, but if buried in their clothes this is not necessary. Great care should be taken to number the graves as the bodies were numbered at the morgue, so that when lifted the record may be found to be correct.

4. The water-supply of the district should be inspected at once, and frequently while the emergency continues. Wells and springs had better be closed if any other water is available. Impure drinking-water must not be tolerated for a moment in these emergencies. Chemical analyses should be made frequently.

5. One or more hospitals for contagious diseases should be established at once, and every case of such disease, as it arises, should be transferred to these hospitals, there to remain until all

danger of spreading the disease is over. This is a point of great importance, and its neglect may result in grave disaster.

6. For the convenience of the survivors and of the laborers who may be brought to the place, it will be necessary for the health authorities to see that public privies, or closets, are erected. These should be placed where most convenient. They should be examined by inspectors of the different districts, and should be under the charge of a careful and reliable foreman, who will daily disinfect them. No foul odors should ever be permitted to arise from these places.

7. If the free discharge from the sewers is impeded by *débris*, these should be opened at once, so that water may be discharged through them freely. In the case of floods it will very frequently be found that the mouths of the sewers have been silted shut. These should be opened. The escape of foul gases from sewers at such a time is not to be permitted.

8. There is always, in time of disasters, danger of the people becoming panic-stricken from fear of a pestilence arising, and in our times well-meaning but ignorant persons are very liable to convey messages to the daily press which tend to excite and distress the survivors. To prevent any panic in this way, the State Board of Health found it necessary to issue occasionally "health bulletins," which stated the exact condition of the public health in the devastated district. These bulletins were printed and posted throughout the whole region, and they were thought to do much good. They were founded on the daily reports received from the sanitary inspectors, from the other physicians in the district, and from the hospitals. In addition to these "health bulletins," the people may be greatly aided by issuing "circulars of information." These circulars describe in the plainest language the proper ways to disinfect the premises, to clean them up, and about what should be eaten, and those things which will best tend to preserve health in the midst of unfavorable conditions. These circulars of information should be placed in each house throughout the district as often as may be deemed necessary.

9. It may, in some cases, be desirable to partially or wholly depopulate the devastated district. This may be done by laying out a town of tents, and then requiring the people to remove from their homes into it. Such a town should be laid out as a military camp, and should be under the same regulations as are military camps. At Johnstown, a partial depopulation only was attempted. The State furnished free transportation to all women and children who desired to go elsewhere to their friends for a few weeks or months, and all were urged to go for a short time. For several weeks, also, transportation was given the men who

applied for the same. In this way the population was largely reduced.

10. If the distress of the survivors is very great, it may be necessary for the sanitary officers to assist the inhabitants in the disinfecting and cleansing of their homes. At Johnstown some thirteen hundred cellars were cleansed by the State, and the *débris* was removed from the streets and lots, wherever it was found to contain the bodies of human beings and animals in numbers sufficient to endanger the public health. This work of cleansing the district can only be considered the work of the State so long as the district is in a condition to be denominated a public nuisance. When this ceases, the work of the State must also cease.

11. So soon as the disinfectants arrive, the sanitary officer must see to their proper distribution and instruct the people as to their proper use. At Johnstown, each sanitary inspector in charge of a district was authorized to open one or more depots, in places most convenient for the inhabitants of his district, in which depots disinfectants were stored. Large placards were then printed and posted over each district, telling the inhabitants where they could obtain disinfectants, and urging them to go and obtain supplies of the same. Circulars of information were given to all who applied, as also oral information, explaining how to use each disinfectant. The result was, that people came by the hundreds and carried the disinfectants to their homes, using them with good effect. These stations should be kept open just so long as the district is in a bad sanitary condition. Reference may be made here to the mode of using some of the more common disinfectants. The *débris* formed of the broken houses and forest trees, together with carpets, bedding, and household effects which had become worthless, were, at Johnstown, destroyed by fire, along with the bodies of the domestic animals. For fully three weeks immense fires were burning at Johnstown, formed of the *débris*, and in these fires hundreds of animals were cremated. In the case of a great flood, those articles which it is desirable to burn may be water-soaked, as was the case at Johnstown. Cremation in such cases may be hastened by the addition of petroleum, though at Johnstown a large donation of tar and rosin, made by the citizens of Wilmington, N. C., was used to aid in the combustion of these wet substances. The rosin was found to have very advantageous properties when applied to the cremation of carcasses. It appeared to destroy the unpleasant odors arising from the burning flesh, and in place gave out an agreeable balsamic fragrance. It also burned with great heat, hastening combustion, and could not be extinguished by heavy rains. By using rosin liberally, and adding driftwood, there was no trouble in entirely destroying the domestic animals with a single firing. The

tar was not so valuable in this work as the rosin. Large quantities of quicklime were used at Johnstown, and found to be very valuable for drying the cellars and absorbing unpleasant odors. The people were advised to whitewash their cellars and homes a number of times, as the lime was believed to be very beneficial. Chloride of lime was used also in sprinkling in the cellars and about the houses. The Board of Health also furnished in solution bromine, chloride of lime, carbolic acid, and Quibbells's disinfectant. These were applied by means of sprinkling-cans. So soon also as the streets were cleared of the *débris*, two sprinkling-carts were set running. These used a solution of disinfectants, which had a good effect upon the general atmosphere, and an excellent moral effect, maintaining the confidence of the people. At times, the workmen who are cleaning up the district will imagine that they detect foul odors, and that it is dangerous for them to work without a liberal use of disinfectants. In these cases the presence of a laborer with a sprinkling-can, applying a solution of disinfectants, produces a very reassuring effect. Disinfectants should be freely used about the morgues and in every place where it can be hoped that they will do good. In this connection it may be stated, to the credit of the manufacturers of disinfectants, that, without knowing the means of the Board of Health to pay them, they promptly filled all orders for their supplies without a moment's questioning.

12. That the district may be entirely within the control of the sanitarian, it is important that, as soon as possible, a house-to-house inspection or survey be made of all the houses which are occupied in the district. This survey should be carefully recorded on blanks prepared for the purpose, and should state whether the house is occupied by owner or tenant, the number of rooms, number of families, the adult males, the adult females, and children under five years of age. It should also state the condition of the cellar, kitchen, and living-rooms. The water-supply should be examined and reported upon, as to source, condition, and amount. The drainage of the premises should be carefully looked into. The privy or water-closet should receive a minute inspection. The surveyor should examine the condition of the yard and stable, and the streets and alleys about the house. Note should also be made of any present sickness in the house, and of the existence of any contagious disease in the house during or within six months preceding. If any deaths have occurred within the house in a year, record should be made of them. With all these points before the Board of Health, if the survey has been made with care, it will not be difficult for the Board to maintain good health in the devastated district—certainly not if they have the confidence of the survivors. If the devastated district

is situated upon a stream, as was the case at Johnstown, it will be necessary for the Board of Health to watch that no cause of disaster to regions below is overlooked. It may be necessary to patrol the river below and open drift-piles and burn the carcasses of domestic animals. If the stream is the water-supply for towns or cities below, at the earliest possible moment it must be placed in a condition not to carry disease to such places.

In a word, in a great national disaster, the Board of Health must be prepared to meet each and every emergency as it may arise.

MISSIONS AND MISSION INDIANS OF CALIFORNIA.*

By HENRY W. HENSHAW.

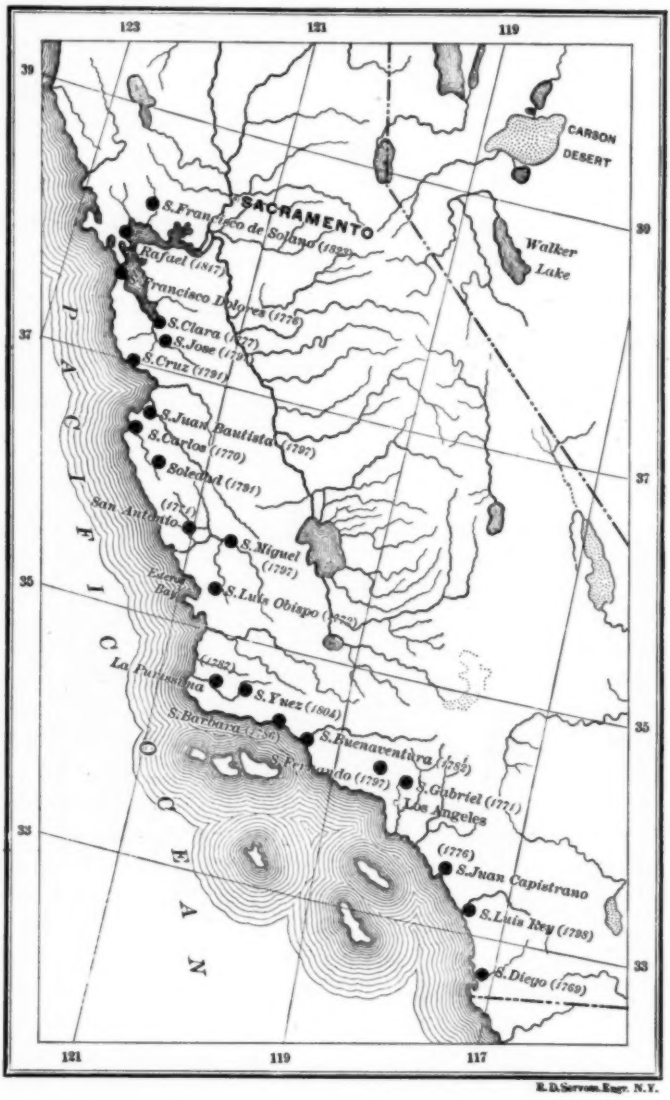
FROM the time of its discovery by Grijalva in 1534 until 1697, a number of fruitless attempts had been made by the Mexican authorities to colonize the peninsula of Lower California, and no small amount of treasure had been wasted in the efforts.

The sole obstacle to the success of the schemes for colonization lay not in the indolent and peaceably disposed Indians, but in the barren and inhospitable nature of the country itself, the wastes of which offered but moderate subsistence to the natives, and nothing whatever to satisfy the love of adventure and the thirst for wealth of the Spaniard. Finding that all attempts to colonize the new country were failures, the Mexican Government turned it over to the Jesuits, who readily undertook its subjection to ecclesiastical authority. The first settlement was made on the Bay of San Dionisio in 1697. The establishment of the missions proper began immediately, and between this period and 1745 no fewer than fourteen were established on the peninsula. It was not until 1769 that the occupancy of Upper California was inaugurated by the founding of the mission of San Diego by the Franciscans, who had superseded the Jesuits in charge of mission work in western Spanish America. From this date until 1823 mission after mission was established to the number of twenty-one, until the entire coast area of California up to and a little beyond the Bay of San Francisco was under mission sway. As mission history forms one of the most interesting chapters relating to the aborigines of this continent, it is the purpose of the present paper to briefly notice the subject, with especial reference to some of the more salient features of mission life and its effect upon the natives.

* The accompanying illustrations are from photographs generously loaned by Mr. S. I. Jannus, who obtained them in 1889.

But, before turning to the subject proper, let us glance at the California Indian as he was found by the missionaries. And first as to his physical appearance.

Vancouver visited San Francisco in 1792, and thus alludes to the natives: "If we except the inhabitants of Tierra del Fuego,



and those of Van Diemen's land, they are certainly a race of the most miserable beings, possessing the faculty of human reason, I ever saw. Their persons, generally speaking, were under the middle size, and very ill made; their faces ugly, presenting a

dull, heavy, and stupid countenance, devoid of sensibility or the least expression."

A few years later, in 1806, Langsdorff describes the same Indians with somewhat more detail, as follows: "These Indians are of a middling, or rather of a low stature, and of a dark-brown color approaching to black. . . . They have large, projecting lips, and broad, flat, negro-like noses; indeed, many of their features, as well as their physiognomy, and almost their color, bear a strong resemblance to the negroes. Their hair is, however, extremely different, being long and straight; if left to grow, it will hang down even to the hips, but they commonly cut it to the length of four or five inches, sticking it out like bristles; this has a very disagreeable appearance in the eyes of a European: the hair grows very far down toward the eyes, so that the forehead is extremely low; the eyebrows are small and the beards thin; many shave them close with mussel-shells. None of the men that we saw were

FIG. 1.—GROUP OF MISSION INDIANS FROM MESA GRANDE, SAN DIEGO COUNTY.

above five feet high; they were ill-proportioned, and had such a dull, heavy, negligent appearance that we all agreed we had never seen a less pleasing specimen of the human race."

The Indians of Santa Clara Mission, many of whom were from the interior tribes, appear to have impressed Langsdorff much more favorably, and he concludes his description of them with the statement that "the people of this mission are,

indeed, generally considered as the handsomest in New California."

The present Indians of San Diego and Los Angeles Counties, a group of whom are presented in Fig. 1, are fair representatives of the mission Indians of southern California. They approach more nearly to Langsdorff's description than to the pen-portrait drawn by Vancouver. It is to be remembered, however, that these Indians belong to the great inland Shoshonian family, and are doubtless intellectually brighter than were their brethren of the coast farther north, about Santa Barbara and San Francisco, who represent distinct families.

I have seen a considerable number of the mission Indians in recent years, and can testify to the general accuracy of Langsdorff's description, though of course they differ much individually and among different tribes. In general it appears to me that the Indians of the interior of the State are less sluggish physically, and are mentally brighter, than those nearer the coast. Taking the coast tribes all in all, they are the lowest type of Indian I have ever seen, and it is probable that they represent the lowest type north of Mexico.

At first this fact seems totally at variance with the fitness of things; for, if California was not literally a land flowing with milk and honey, it possessed every attribute to be desired by a barbarous people. Its climate was mild and equable; its coast and inland waters teemed with fish and mollusks; while the land abounded with game and with nuts, roots, and seeds which were both nutritious and easily procured. With such advantages as these it might be supposed that the natives would have far outstripped the dwellers of less favored sections. Human progress, however, does not always follow the lines of least resistance, and it is probable that in their struggle toward civilization the races of the world owe less to their advantages than to their disadvantages. To put this seeming paradox in other words, man's improvement has been largely compulsory, and, when he is not too heavily handicapped, adverse surroundings stimulate instead of checking his progress. Certain is it that the fine climate and abundant natural products of California had their full effect in developing, or rather in retarding the development, of the natives. Though not deficient physically, the Indians, especially of the warmer portion of the State, were exceedingly indolent and stupid. As a rule they were not hunters but fishers, and hence their blood was not quickened and their muscles hardened by the excitement and toil of the chase; nor were their wits sharpened to the same extent as those of the hunting tribes by the manifold and varied necessities of their calling, nor by the sterner duties of war; for the hunting tribes are invariably warlike. Not so the Califor-

nians; though there was a multiplicity of tribes and an abundant population, and hence ample cause for intertribal strife, their warfare was in keeping with the rest of their character, and had in it little of the aggressive fierceness which characterized other Indians to the eastward. No better evidence of their pusillanimous spirits need be required than their abject submission to mission rule, enforced as it was at each mission by the presence of two or three priests and only a half-dozen armed soldiers.

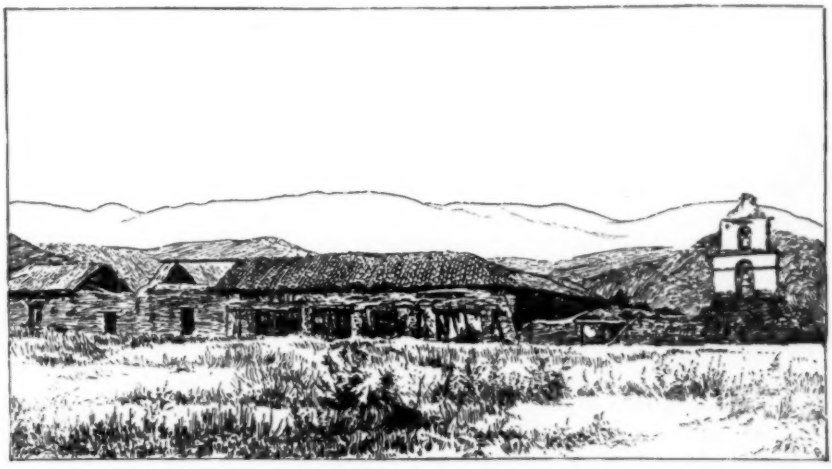


FIG. 2.—RUINS OF BRANCH MISSION OF PALA, TWENTY-FIVE MILES EAST OF SAN LUIS REY; ESTABLISHED IN 1816.

Though the natives of southern California, as the result of living under rather similar conditions of environment, conformed in a general way in physical appearance and in their mode of life, it must not be supposed that there were not very many distinct tribes which differed in many minor particulars. Within the mission area there were scores, if not hundreds, of tribes—just how many we can not tell—and they were divided among no fewer than nine distinct linguistic families. Perhaps the linguistic differences that characterized these tribes formed the most remarkable point of distinction, and it is doubtful if anywhere else in the world within the same area have there ever been observed so many distinct families of language and so many dialects as in California. As Lamanon remarks, "It is the difficulty of learning all the languages that consoles the missionaries for their not knowing any." In point of fact, the language changed dialectically every ten or fifteen miles, while totally distinct linguistic families succeeded each other in bewildering profusion.

The California tribes were in no sense nomadic. That to some extent they changed their place of abode with the season is doubtless true, and in winter the tribes living immediately on

the more exposed parts of the coast moved inland a greater or less distance.

Although by no means densely populated according to modern ideas, yet California was well divided up among the numerous tribes, and was probably more completely occupied than any other part of the United States. This is attested by the accuracy with which the tribal lands were marked off, in many places by artificial boundaries, as also by the rigidness with which trespass on the territory of neighboring tribes was punished. Population must be large, and the natural products of the soil of considerable value, ere land rights are so carefully guarded. A large population is to be inferred also from the proximity of the missions to each other, since each one required a populous area from which to draw its converts; and, finally, a large population is attested by the mission figures, which show that during the mission period, from 1769 to 1834, some seventy-nine thousand converts were baptized; and yet this number can not by any means have represented the total population for the sixty-five years, since by no means all the Indians were converted.

As the Californian Indians were practically in the same culture state as those of other portions of the United States, though upon a somewhat lower plane, I need not dwell further upon their habits save to say that they lived in conical or wedge-shaped lodges of *tule* or thatched grass, or in temporary wigwams of branches; wore very little clothing; lived largely on fish, mollusks, and seeds, and to a less extent upon game; for the most part made no pottery, but employed soapstone for domestic utensils when that material was available, or used basketry vessels when it was not; were very fond of ornaments; had a complex mythology; resorted to their *shamans* for the cure or prevention of disease, for the destruction of enemies, either personal or tribal, for luck in hunting or fishing; and, finally, were fetich-worshipers. Such were the people to enlighten and Christianize whom was to be the life-work of the Franciscan fathers. Let us now observe the methods adopted for these praiseworthy ends.

The Spanish and Mexican authorities did not intend that the mission reign should be permanent. The viceroys of New Spain saw in California an important political addition to Spanish-Mexican territory, and even when secular colonization failed, and the attempt was abandoned in favor of ecclesiastical methods, the approved plan of the Government for the mission establishments contemplated these as but a temporary means to an end, and full provision was made for the conversion of the missions into secular establishments, quite independent of priestly authority, and for the conferring of citizenship upon the Indians. To this latter end it was provided that after ten years' service in the mission an In-

dian might claim his liberty, provided a respectable settler would become responsible for his good conduct. It was the clearly expressed idea of the Government that the Indians should be rendered self-supporting as rapidly as possible, and the missions were looked upon as educational establishments to this end. Though not openly antagonizing these provisions, the fathers never yielded a hearty assent to the policy, and from the very first sought to render the converts totally dependent and to establish between themselves and their charges the relation of father and children, in which policy they were only too successful. It was no part of their plan to make the Indian self-supporting. The danger of mission disestablishment disturbed the missionaries little, as they openly said the Indians were incapable of self-maintenance.

For its own support and the maintenance of its converts each mission had allotted to it fifteen square miles of land. The buildings were laid out in various ways—sometimes in the form of a square inclosed by a high wall, and sometimes in detached sections. To each mission was allotted a well-built church; and though externally these presented a rather rude appearance, yet their interiors were finished with considerable care, and lavishly decorated as far as the circumstances permitted. Among the pictures that

FIG. 3.—MODERN HUT OF MISSION INDIANS, COAHUILA VALLEY. RAMONA AND CHILDREN IN FOREGROUND.

hung upon the church walls were always to be found two, representing respectively hell and paradise. The former depicted in the most vivid way the future torments of the unregenerate, and it proved a very effective means of conversion.

The houses of the neophytes were usually a little distance from the mission proper, and consisted of open rows of little huts. The accompanying sketch (Fig. 3) affords as good an idea of these

primitive structures as is to be found among the modern mission Indians, and is quite primitive. The roof is composed of thick branches of a kind of sage-brush, and the pole wattles constituting its sides are chinked with mud.

Late in mission history the houses were built of sun-dried bricks, and were reasonably comfortable habitations, but in the early period they were most miserable affairs. Vancouver describes them in 1792, and they were evidently nothing but the native huts, made of willow saplings planted in the earth and brought together at the top, with twigs interwoven and with a thatching of grass and rushes. Vancouver says of them: "These

FIG. 4.—ADOBE HOUSE OF MISSION INDIANS, COAHUILA VALLEY, SAN DIEGO COUNTY.

miserable habitations, each of which was allotted for the residence of a whole family, were erected with some degree of uniformity, about three or four feet asunder, in straight rows, leaving lanes or passages at right angles between them; but these were so abominably infested with every kind of filth and nastiness as to be rendered not less offensive than degrading to the human species."

Fig. 4 shows the modern adobe house, the use of adobe being introduced into California by the Spaniards.

The fact is, that in the aboriginal state the sanitary condition of the Indians was preserved by seasonal changes of residence, or by burning the houses, for one reason or another, chiefly superstitious. They probably never burned them of their own accord

to be rid either of vermin or filth, as the idea of cleanliness for the sake of cleanliness is foreign to the savage mind. Constant residence in one spot, under such conditions as Vancouver and others described, had its legitimate effect upon the health of the neophytes, as we shall see.

In these huts lived the married only; the unmarried were domiciled in separate buildings, usually directly under the eyes of the missionaries, where they were locked up at night, each sex separate. The unmarried women also worked separately, and always under supervision.

When the missions were first established, the good fathers, as a rule, experienced little difficulty in securing converts. Kind words, and the gifts the Indians received in the shape of food and clothing, proved an efficient means of conversion, and they were baptized in gratifying numbers. Converts were encouraged to visit their wild brethren at home, and by flattering accounts of mission life induced many to return with them. As neophytes grew scarce, the area from which they were drawn was extended, and a greater or less number of recruits was obtained from the distant interior tribes. Later, such means proved unavailing, and other and more questionable methods were resorted to. Upon one pretext or another, armed soldiers and armed converts were sent out who frequently returned with a goodly number of captives; and, for two reasons, these were mostly women and children: first, because they were preferred, since the husbands frequently followed them into captivity; and, secondly, because in the conflicts which preceded the capture of the wives and children many of the men were killed and the rest driven away. In these conflicts the wounded appear to have received little mercy. Beechey witnessed the tragical issue of one of these holiday excursions by the neophytes of the mission of San José, and we are indebted to him for the details. An armed launch had been placed in charge of an alcalde of the mission, who while on the trip planned an attack upon the Cosemenes of the San Joaquin, either directly for the purpose of securing converts or in revenge for some aggression. While in camp near the village they intended to attack, the neophyte party was surprised by the Cosemenes, and thirty-four were killed or taken captive. In this case apparently the alcalde acted without authority, and doubtless without knowledge or connivance on the part of the priests. However, when the news reached the mission it was thought necessary to strike terror into the victorious tribe, and accordingly an expedition was sent against them. The result was that forty men, women, and children were killed and forty women and children were captured and brought back to the mission. Thus the loss of the converts was more than made good, the surrounding tribes were in-

spired with terror, and all with the loss of one Christian, who was killed by the bursting of his own gun. Such acts reveal the darker side of mission history, and the attempt has been often made to free the priests from the blame of such transactions, on the ground that they were ignorant of the extreme means employed. Such

FIG. 5.—COAHUILA INDIAN, FORMERLY A NEOPHYTE OF SAN GABRIEL MISSION, LOS ANGELES COUNTY.

can hardly have been the case. Even when the ostensible purpose of the visits of the converts was peace and not war, they were armed, the boat being often provided, as Beechey tells us, with cannon and musketry. Under such circumstances of superiority it would have needed no prophet to foretell the probable action

of Indian neophytes, doubtless often with old grudges to pay off and eager to find favor in the eyes of their masters, and to claim the reward of their zeal in the new faith. Another fruitful occasion for wholesale capture was the escape of converts to neighboring tribes, and the attempt to recapture them by armed force, to which are to be added, of course, the petty manifestations of hostility on the part of the unconverted tribes. Overt acts on their part were followed by reprisals, and these always meant a fresh supply of converts.

Having gained possession of their subjects, the next step was to convert them to Christianity—a process neither very long nor tedious. Before baptism it was customary to prepare the candidates—if the term be applicable to unwilling captives—by preliminary instruction, which the padres state never occupied less than eight days. How clear an insight into the mysteries of the Christian religion a pagan Indian, fresh from the worship of his fetiches, is likely to obtain in eight days may be imagined; but the fathers declared that the instruction was ample. The usual method of enlightenment is thus detailed by Beechey:

"Immediately the Indians are brought to the mission they are placed under the tuition of some of the most enlightened of their countrymen, who teach them to repeat in Spanish the Lord's Prayer and certain passages in the Romish litany; and also to cross themselves properly on entering the church. In a few days a willing Indian becomes a proficient in these mysteries, and suffers himself to be baptized and duly initiated into the church. If, however, as it not unfrequently happens, any of the captured Indians show a repugnance to conversion, it is the practice to imprison them for a few days, and then to allow them to breathe a little fresh air in a walk round the mission to observe the happy mode of life of their converted countrymen; after which they are again shut up, and thus continue to be incarcerated until they declare their readiness to renounce the religion of their forefathers." A remark by Beechey that he thought the teachers had an arduous task, elicited from the priest the reply that "they had never found any difficulty; that the Indians were accustomed to change their own gods, and that their conversion was in a manner habitual to them." This was undoubtedly true, as was evidenced by the rapidity with which numbers apostatized in favor of their earlier gods whenever occasion offered.

Discipline among the converts was administered with some severity. As was to be expected, desertion and the non-performance of their religious duties were the chief occasions of punishment. A church-service is thus described by Beechey (page 367):

"After the bell had done tolling, several *alguazils* went round to the huts to see if all the Indians were at church; and if they

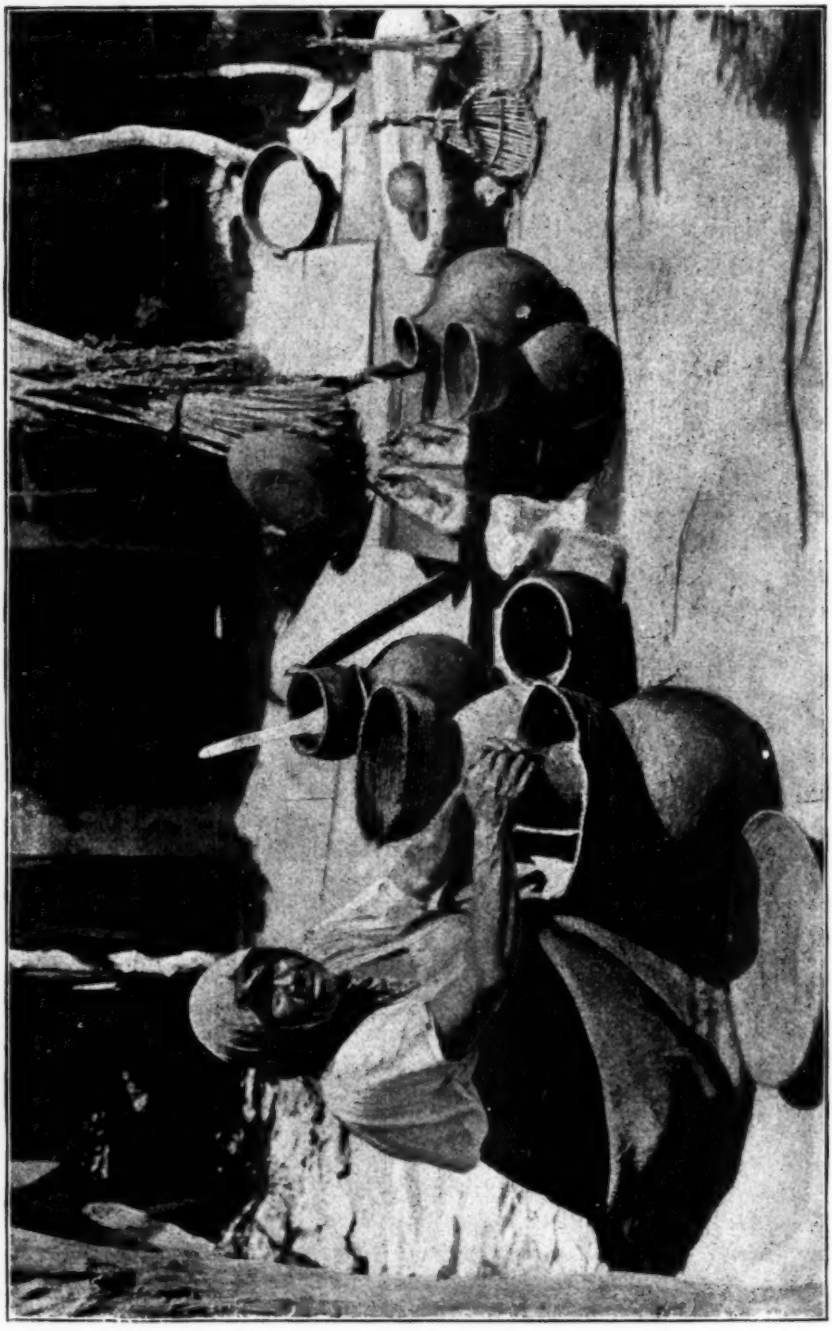


FIG. 6.—COAHUILA MISSION INDIAN GRINDING SEEDS. INDIAN POTTERY, BASKETS, SEED-BEATERS, ETC.

found any loitering within them, they exercised with tolerable freedom a long lash, with a broad thong at the end of it—a discipline which appeared the more tyrannical, as the church was not sufficiently capacious for all the attendants, and several sat upon the steps without.

"The congregation was arranged on both sides of the building, separated by a wide aisle passing along the center, in which were stationed several *alguazils* with whips, canes, and goads to preserve silence and maintain order; and, what seemed more difficult than either, to keep the congregation in their kneeling posture. The goads were better adapted to this purpose than the whips, as they would reach a long way, and inflict a sharp puncture without making any noise. The end of the church was occupied by a guard of soldiers under arms, with fixed bayonets—a precaution which I suppose experience had taught the necessity of observing." The spectacle presented of church doors guarded by soldiers, and of attendants provided with whips and goads to prick the unwilling or ignorant into kneeling, is certainly not a very edifying spectacle according to later ideas, and savors far too much of slavery. Indeed, the resemblance was suggested to more than one eye-witness; and Pérouse finds in the system an unhappy resemblance to the slave plantations of Santo Domingo. He says: "With pain we say it, the resemblance is so perfect that we have seen men and women in irons or in the stocks; and even the sound of the lash might have struck our ears, that punishment being also admitted, though practiced with little severity."

It is not improbable that there were occasional instances in which undue severity was exercised in punishment, but it is safe to conclude that cases of actual cruelty were not common. When such occurred, it is probable that they were the acts of the subordinate officers of the missions, who were chiefly Indians, and that they were not sanctioned by the priests. Nevertheless, the charge was more than once made by the Government authorities. Offenders were punished by fetters, the whip, and the stocks, and by imprisonment. Estudillo says that the friars treated the neophytes as their children, correcting them with words, and for serious offenses with from twelve to twenty-five lashes. Subsequently the latter number was the extreme limit fixed by authority, the implication being that occasionally at least this number had been exceeded. A deserter, says Langsdorff, was bastinadoed, and an iron rod a foot or a foot and a half long was fastened to one of his feet.

From the very first the fathers adopted the policy of compelling the neophytes to work. By this means not only were they instructed in certain useful occupations and kept out of mischief, but by the products of their labor the missions were largely sup-

ported and a considerable revenue derived from the sale of such products to the *presidios*. All the agricultural and manufacturing work was performed by the Indians. Each mission had a large flock of sheep, the eleven missions in 1800 possessing eighty-six thousand. The Indians sheared the wool, and spun and wove it into blankets and coarse fabrics for clothing. They also made

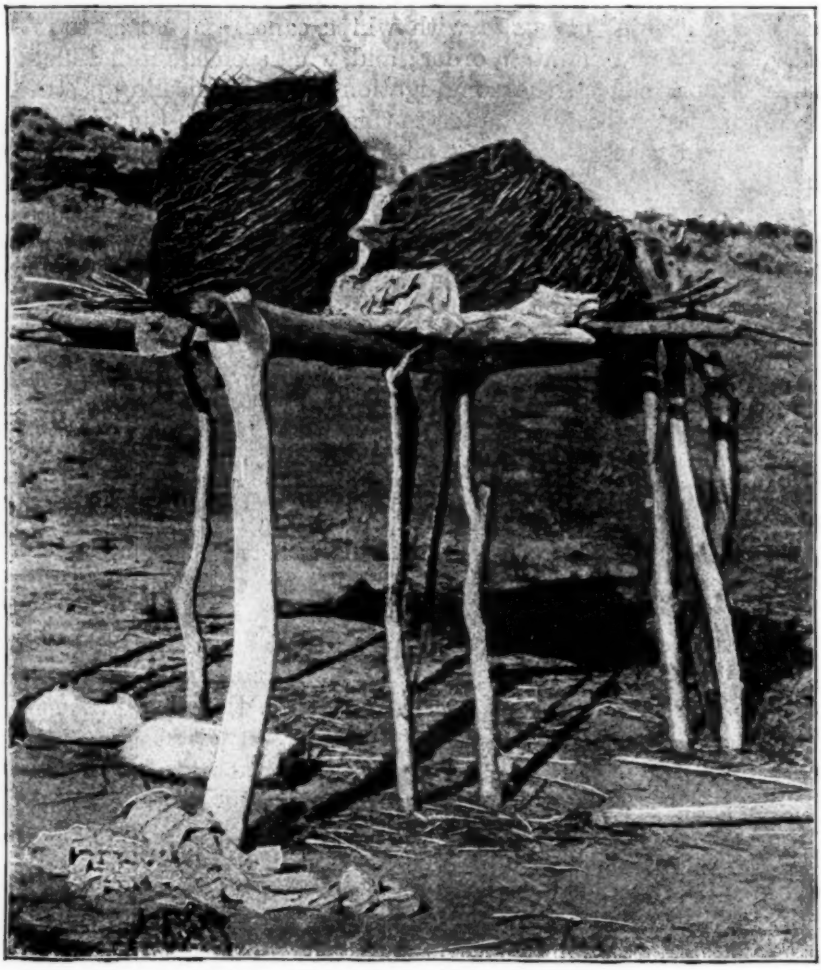


FIG. 7.—ABORIGINAL GRANARIES MADE OF WILLOW.

soap, and tanned the skins and hides; they were the shoemakers and saddlers, the carpenters and blacksmiths.

With respect to the number of hours the neophytes were compelled to labor, there seems to be some doubt. In reply to the commandant's charge that the neophytes were compelled to work from six to nine hours a day, with extra work on special occasions

as in harvest-time, and that the tasks laid upon both women and men were too heavy, the fathers asserted that the working hours were only from four to six hours, and that tasks were light, since not more than one half the neophytes worked at any one time, being excused on one pretext or another; and that even when they did work they never worked hard. Those familiar with the Indians will be likely to accept the statements of the missionaries, since to induce the average Indian, half or wholly wild, to overwork himself in steady toil would require a much more severe *régime* than there is any evidence was ever employed at the missions.

Pérouse has left us an account of a day's routine at one of the missions, and, as the methods varied but little at the several establishments, it will probably answer for all: "The Indians, as well as the missionaries, rise with the sun and go to mass, which lasts about an hour. While this is in progress the breakfast is prepared, the favorite *atole* or pottage, which consists of barley-flour, the grain being roasted previously to grinding. It is cooked in large kettles, and is seasoned with neither salt nor butter. Every cottage or hut sends for the allowance for all its inmates, which is carried home in one of their large baskets. Any overplus that remains is distributed among the children as a reward for good behavior, particularly for good lessons in the catechism. After breakfast, which lasts about three quarters of an hour, they pro-

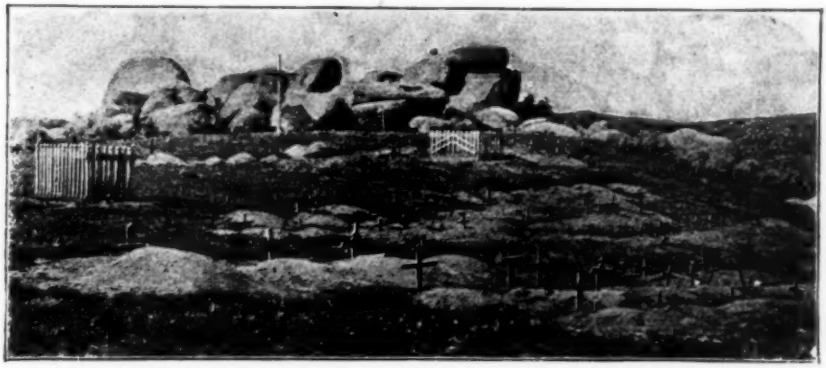


FIG. 8.—MISSION INDIAN GRAVEYARD IN COAHUILA VALLEY, SAN DIEGO COUNTY.

ceed to their labors, either out of doors or within. At noon the dinner is announced by a bell, and the Indians quitting their work go and receive their rations as at breakfast-time. The mess now served is somewhat of the same kind as the former, only varied by the addition of maize, peas, and beans; it is named *pozzoli*. After dinner they return to their work, from two to four or five; afterward they attend evening mass, which lasts nearly an hour, and the day is finished by another supply of *atole*, as at breakfast.

In the intervals of the meals and prayers the Indians are of course variously employed according to their trade or occupation—that is to say, either in agricultural labors, according to the season, or in the store-rooms, magazines, and laboratories of the mission. The women are much occupied in spinning and other little household labors, the men in combing wool, weaving, melting tallow, etc. One of the principal occupations of the missions is the manufacturing a coarse sort of cloth from the wool of their own sheep for the purpose of clothing the Indians. The grinding the corn is left almost entirely to the women, and is still performed by a hand-mill."

It was a shrewd stroke of policy on the part of the fathers to allot the laborious work of grinding meal to the women, in whose hands it had been from time immemorial, since the men would have stooped to such labor only by dint of the strongest coercion.

FIG. 9.—MODERN MISSION INDIAN ON HIS TRAVELS.

With reference to the grinding of corn, Langsdorff (1806), learning that the hand-mill which Pérouse, out of the kindness of his heart, left at the San Carlos Mission (1786), with the view to lighten the heavy labor of the mealing-stones, was not in existence, and that no use had been made of it as a model to manufacture others, records the curious fact that in perpetuating the use of the stone grinding process the fathers were actuated by motives of policy. To use his own words, "As they have more men

and women under their care than they could keep constantly employed the whole year, if labor were too much facilitated, they are afraid of making them idle by the introduction of mills." With the fathers the important question was, not how many converts can be well instructed, and by what method can their progress to civilization be best facilitated, but how many can be got together to be baptized and saved from the devil. Not improvement but conversion was their guiding motive.

There is no good reason to believe that the neophytes were not well fed, though the contrary was asserted by officials inimical to the mission policy. That their fare lacked variety is probable, but there was enough of it, and it was served three times a day, as Beechey tells us, adding that it consisted of "thick gruel made of wheat, Indian corn, and sometimes acorns, to which at noon is generally added meat."

That the rule at the missions was not all work and no play is evidenced by the fact that the neophytes were allowed to indulge in their own habits and customs so far, says Langsdorff, as "they are not inconsistent with their new religion. In their dances, their amusements, their sports, their ornaments, they are freely indulged." Like other Indians, they were great gamblers; and, whether by the tacit permission of the priests or not, they indulged freely in the passion, chiefly by means of games of their own invention. Drunkenness was more or less common among them.

The picture of the California neophyte under mission rule thus presented, while having its dark side, is by no means a revolting one, and at first sight it might be supposed that the Indians under such a system should be better off and happier than in their original condition. They were well fed, well clothed, if not well housed; their tasks were not heavy, a reasonable amount of amusement was allowed, and they needed to take no thought for the morrow, for everything was provided. While it must be evident at once that such a system could not but prove an absolute failure as regards the true civilization of the Indian, it does not immediately appear why he should not have been contented with his lot. If he was not contented, the fault lay with the system or the Indian, and certainly not with the personal character of the priests; for, while there were a few black sheep among them, as a body they represented a high standard of benevolence and integrity. All who visited the missions in the early days extol the fathers for the unselfish spirit with which they devoted themselves to what they believed to be the welfare of their subjects and their kind-heartedness. It is doubtful if a purer and more devoted set of men ever labored for the good of the heathen than the early missionaries of California. Having power the most

absolute, in the main they wielded it with moderation if not always with discretion; and, if they placed the spiritual welfare of their children above their earthly good, it was due to the times and their calling. It may be added that the same error is too often to be discerned in missionary systems the world over. In order to Christianize, the missionary should first educate.

The best proof of the good character and kindness of the fathers is to be found in the fact that many of the neophytes cherished an unbounded affection for them, as is attested by many contemporaries. Nevertheless, from first to last of mission rule, discontent was rife among the converts, and had the mission Indian possessed but a spark of the courage which characterizes our Eastern tribes, mission sway would have been short-lived. Imagine a body of Iroquois driven to church by the whip, or forced to kneel by being punched with goads! The evidences of discontent appear in the threatened uprising at all the missions and the actual revolts at several, by the hostile attitude of all the gentile tribes who were brought into direct or indirect relation with the missions; and, above all, by the numerous yearly desertions at every establishment. The causes of trouble are not far to seek. In the first place it is evident that, call it by what name you will, the neophytes were subjected to a state of slavery—a slavery, too, which galled, however mild the type, but from which they found it exceedingly difficult to escape; for, in addition to the aid of the soldiers in hunting renegades, the priests could usually count upon the assistance of the gentile tribes to return fugitives. The wild Indians hated the neophytes, and the rule among them was—once a neophyte always a neophyte. How strongly linked was the chain which bound the neophyte appears in the provision that, even when liberty was given him after ten years' service, a portion of his earnings was still claimed by the Church. The crops the neophytes were compelled to sow were sown mainly for the profit of others, the harvests they reaped were not their own. Thus the usual incentives of toil were absent. Though professedly regarded as a child by the fathers, the Indian was virtually a slave.

The sudden breaking up of all tribal ties and the substitution of arbitrary authority for the independence of the liberty-loving Indian, together with the complete change of life, must also have been irksome and productive of unhappiness.

Possibly, however, the most potent of all causes for discontent is to be ascribed to the fearful mortality which from the very first raged among the mission folds. Its sources are somewhat obscure, although it is safe to attribute it largely to what may be termed unnatural conditions of life. It is stated, and it may be readily believed, that when visited by even trifling disorders the

Indian became despondent, generally refused to be ministered to, and often died without apparent adequate cause. The Indian rarely has much faith in civilized medical methods, and when really sick almost invariably prefers the ministrations of his own *shaman*. Moreover, in the case of the California Indians there is reason to believe that their want of faith in the skill of the padres was well founded; for both Beechey and Langsdorff, differing from Vancouver, note the astonishing amount of sickness among the converts, and comment upon the lack of medicines and the ignorance of the fathers as medical advisers.

Acknowledgments are due to Hubert H. Bancroft, not only for a mass of hitherto unpublished facts relating to mission history, but for many statistics of baptisms, births, deaths, etc., which he has culled from mission archives. These are given by decades for every mission. From these it appears that during the mission period, from 1769 to 1834, an interval of sixty-five years, seventy-nine thousand converts were baptized and sixty-two thousand deaths were recorded. An analysis of the statistics furnished by Bancroft reveals the fact that the death-rate among the neophytes was about twice that of the negro in this country, and no less than four times as great as the death-rate of the white population.

At no time would it appear that the number of the births among the mission converts was equal to the deaths. According to Bandine, the governor states, in a report for 1800, that the number of deaths is almost double that of births; and again, in 1815, the president of the missions stated that there were three deaths to two births. It was only by perpetual drafts upon the surrounding tribes that the missions were sustained at all. The high death-rate and small birth-rate explain what has become of the California mission Indian. The former can not be attributed to ordinary diseases, even when is taken into account the despondency of the Indians when sick and the lack of proper medical treatment. The records show that epidemics of small-pox, measles, pulmonary diseases, and intermittent fever prevailed at several periods, and all observers testify to the early introduction of syphilis among the natives and to its severe ravages. With this knowledge, perhaps it is not necessary to inquire further. When are taken into consideration the unnatural herding together of large numbers of Indians under the most unsanitary conditions, practically without medicines and without proper medical attendance, the ordinary effect of disease being heightened by the dejection of the patients, and then add an epidemic or two of any of the above diseases, and the probable result may easily be foretold. The wonder is, not that the Indians died off rapidly, but that any of them survived.

How many of them actually did survive can not be told, but the number was relatively very small. The decree for the disestablishment of the missions was made by the Spanish Cortes in 1813, but it was not carried into final effect until 1834. Between 1820 and 1830 there was a gradual but marked decline in mission prosperity. In 1834 the twenty-one missions contained fifteen thousand converts; but earlier than this the constant drafts upon the native tribes had about exhausted the supply, and by 1830 no more converts were to be had within reach of most of the missions. In fact, most of the natives had been converted out of existence.

The wealth of the missions was no mean dowry for the surviving neophytes, for collectively they now contained among other property one hundred and forty thousand cattle, twelve thousand horses, and one hundred and thirty thousand sheep; which totals, though reduced from previous years, will afford some idea of the wealth resulting from convert labor and missionary overseeing. The missions had been more successful in the accumulation of property than in civilizing the Indians.

As has been stated, the original plan of colonization contemplated the Indian as a citizen in individual possession of land, each with his share of the accumulated mission property, consisting of horses, cattle, sheep, etc. The experiment of giving the Indian his freedom, so long contemplated, was now (1834) to be tried. The fathers, facing the inevitable, recommended that a partial trial be made first, as they believed that the Indian was not ready for the experiment; and, indeed, how was it possible that he should be? Had the intention from the very first been to unfit him for independent existence, no better plan could have been devised than the one actually followed. Educated he was not, except in the necessary portions of the ritual of the Catholic Church, and in so far as a certain number spoke Spanish. Civilized he certainly was not, since his knowledge of the art of husbandry and of the manual arts was only sufficient to enable him to be a producer under task-masters. He was, in fact, master scarcely of the rudiments of civilization. In short, at the end of mission rule, the Indian was really less capable of taking care of himself than at the beginning: he was found a free man—he was left a dependent.

Could the provisions of the secularization act have been carried out gradually and honestly by capable officers and with the co-operation of the missionaries, even then it may be doubted if the intelligence and civilized attainments of the Indian would have been equal to the occasion. As it was, political considerations prevented a fair trial of the plan, and the final act in the mission drama is little else but a history of robbery and oppres-

sion, in which the Indian, as usual, was the sufferer. The vast mission herds and flocks melted away; the implements which were intended for the use of the Indian farmers were not, as a rule, forthcoming; and, of course, without domestic animals and without the means of tillage, the land was of no use. The Government, though possessing no claims whatever upon the mission property, made frequent demands upon it, and, as Bancroft states, the period from 1836 to 1842 was one of disaster in mission history. The downward path of the natives was rapid. Those who obtained property sold it and converted the proceeds into liquor and then resorted to stealing, to flight to the wild tribes, or to return to bondage under the guise of servants in the town or on the ranches. In the area between the Bay of San Francisco and Los Angeles there are to-day probably not one hundred Indians. Of the so-called mission Indians in San Bernardino and Los Angeles Counties, the last Indian report gives a population of four thousand three hundred and thirty. But very few of these are descendants of the mission Indians of Franciscan times.

Such, in brief outline, is the history of the mission Indians. They lived and died, and their few descendants now drag on a miserable existence in out-of-the-way places, so poor and barren as to be beyond the covetousness of the whites, or live dependent wards of the Government.

MENTAL STRAIN.

By M. CHARLES RICHET.

A BOOK on mental over-pressure has been written by Madame Manacéine for the protection of the men who are to follow us. A continuance of the kind of life that is now led in the great centers of civilization will involve the risk of compromising the lot of future generations. We are going blindly, groping, toward a new humanity, to issue from us, of which we can not predict the character. This humanity is in danger of being a poor affair indeed, from whatever point of view we may regard the case, unless we conduct ourselves better. Madame Manacéine has undertaken to analyze the present conditions of existence, physiological and psychological; to exhibit us to ourselves as we are; to draw a balance-sheet of our mistakes in habits and education, for the avoidance of a threatened decay. We owe her thanks for her generous and patient attempt.

We have no right to be unconcerned about the future of mankind. We have an account to settle with the men of coming ages. We must be careful for them. They are worthy of our interest

and forethought, and we should be very culpable if we did not have some care for the fate of our great-great-grandchildren.

The prominent characteristic of living beings, of whatever kind, is the tendency to resemble their parents. It is fatal, irresistible, and dominant in all biological laws. By heredity we acquire this or that trait of our fathers, whether it be natural or acquired in them. The consequence of this fact is momentous, and has been admirably set forth by M. Marion in his book on Moral Solidarity. It is, that our children will be the same as we have been. They are our image and the faithful portrait of ourselves. A vice acquired by us will become natural with them. An accidental physical or moral blemish, brought on by our faults, or errors, or carelessness, will become in them a natural blemish, and they will transmit it to their descendants.

Unless we are now able to preserve our mental and bodily forces intact, our grandchildren will be victims to our faults. They would even have the right to a certain extent to call us to account for our careless conduct. "What did you do with that vigorous body and healthy and sturdy mind that were given you by your parents? for it is by your fault that we are miserable and sickly." The importance of the question is thus well established. Since the future depends on the present, it is no less than a question of the future of men. This being fixed, the query arises, Is there mental overstrain? A careful examination of the facts gives us occasion to answer affirmatively. In consequence of the prodigiously artificial conditions of existence which our advanced civilization has imposed upon us, we have greatly modified the habitual and physiological life of our organism. A close study of the habits of contemporary men, such as the author of this book has made, will show that nothing is less in agreement with a healthy vitality than the mode of living of to-day.

From very early years children are shut up in work-rooms for many hours with tiresome books. They have no sufficient distraction from these books, no better prospect of good to be derived from them than the hope of some time passing an examination, complicated, hard, and encyclopedic, of a compass surpassing that of the knowledge of the wisest man that can be imagined. Then, in youth there are still examinations, still hours of study, still books, with only the scantiest provisions for diversion and recreation, except by resorting to fatiguing dissipations. Too much civilization, too much mental culture, with too little care for the physical part. Do we forget that the material structure is the organ of the mind, and that the mind can not maintain itself in an enfeebled body? We ought to realize that sooner or later the body will avenge itself. We can not break away with impunity from the laws of sound psychological hygiene. The

muscle that is not exercised becomes atrophied; the muscle that works too much becomes diseased. The mind that is not exercised decays; the mind that labors too much is distorted, and we reach the sad result of weakening the understanding by the excess of labor to which we subject it, of destroying the instrument we use.

The philosophers of the eighteenth century extolled what they vaguely called a return to the state of nature. They imagined that man was primarily a perfect being, and that, as his intellectual and social growth have gone on, he has correspondingly degenerated and become vicious. Nature did well, they said, but civilization made him wicked. The reverse of this, however, is nearer the truth; and if we had to look for types of moral perfection, we should not go among savage peoples. Neither do savages excel the civilized races in vigor and health of body. But while we recognize that savages are not men whose bodies and minds are in a supreme condition of excellence, we have to acknowledge that civilized man has singularly neglected his body, that vesture to which it is necessary to attach some importance; for, without that vesture, there is no man.

It is indeed hard to maintain the equilibrium of body and mind. If we should try to lead an exclusively animal life, devoted to eating, walking, sleeping, and making love, we should find such existence insipid enough. We could not maintain it if we would, for there are a thousand features of our present life that we could not eliminate. But we can and should recommend and require that a considerable place be given to physical exercise. English youth, who practice passionately at cricket, cycling, and canoeing, are at the same time good Hellenists, and often excellent mathematicians. It is all the better for the mind to work, on condition that the body is also exercised. A sound mind in a sound body was the ancient maxim of the school of Salerno, and no better formula has yet been found. Let us, then, have some regard for the well-being of the body. Let us learn to keep our muscles in full energy, to breathe the fresh and bracing air of the mountains and the sea; or, if these are too far away, the air of the fields around our towns. By brief distractions of this kind we will benefit the mind.

The sad thing about the matter is, that it is not so much intellectual labor, of which the mind is capable of doing a great deal, as irregularities in that labor, that do the harm. We are satisfied that the great workers, who have performed grand achievements by genius or patience, owe their triumph less to a temporary excess of labor, than to continuous, regular, persevering work,*

* Littré, one of the greatest workers that ever were, passed his whole day out of doors, and never began to work till evening, at half-past seven, after dinner, and then stayed in his library, bent over his books, without any relief, till about four o'clock in the morning.

interrupted by regular and systematic recreations. Above all—and it is the most important point—it is necessary to abstain from excess. Moderation, the just mean, which has been so frequently and so foolishly ridiculed, is in this matter, as in many others, true and practical wisdom. Not to force children to excessive work in school, to be able to take rest, to limit our ambition and desires as much as possible, to live for a few hours a day a purely animal existence, are what we ought all to try to do; and we should be recompensed for it very quickly by better moral and physical health. The value of that boon can not be overestimated. If we represent the coefficient of happiness by 100, 95 of the marks should go to health, while fortune and fame would only deserve the other 5. The affair is one of habits rather than of regulation, and legislation can have little effect upon it. Our duty is clear. The first thing is to reform the education of children and youth. Everybody should be made to understand that mental labor can be good only as it is moderate and accompanied by bodily exercise. Bodily activity should be encouraged, class-hours diminished, and play-hours increased. All this appears simple enough, and easy, for everybody is at bottom agreed upon it. They all preach moderation, and it has a fine sound. But is it ever easy to be moderate—that is, wise?

Civilization has certainly enormously extended our knowledge of every kind. A well-informed man to-day must know some three times as much as he would have had to know two hundred years ago; and in another hundred years he will have to know as much more. But there is a limit to our mental capacity. We must learn to restrain ourselves. Instead of being encyclopedists, we shall have to be specialists; and, even in our specialty, will have to moderate our studies. We must never let physical needs—the open air, exercise, and sleep—be sacrificed to the demands of school examinations or the life of society.

We will end with a trite quotation. But trite quotations are the best, because they recall uncontested and incontestable truths. "Man," says Pascal, "is neither an angel nor beast." We shall have to submit to being, partly at least, animals, and consequently to take care of the animal which is half and perhaps a little more than half of ourselves. If the animal suffers, the angel will be ill. The future is for the races that do not sacrifice their bodies.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

As he lived in the same house with M. Barthélemy-Saint-Hilaire, he sometimes, when about to retire, met his friend going to work; for M. Barthélemy-Saint-Hilaire was accustomed to begin at daylight. M. Littré led this laborious life, with inexorable regularity, for more than fifty years.

ANCIENT AND MODERN IDEAS OF HELL.

By FREDERIK A. FERNALD.

THE idea of a place for the punishment after death of wicked men is found in most, though not all, of the religions of the present time and of antiquity. According to some beliefs, the punishment is to last forever; according to others, the torments are to continue only for a time, and are to result in purifying the imprisoned souls and fitting them for heaven. The Roman Catholic religion has both a purgatory, or place of temporary torment, and a hell, which is everlasting. No idea of penalty was connected with the classic hades—it was simply an under-world where dwelt all those who had the misfortune to be dead, irrespective of their conduct in life. The word comes from the Greek adjective Ἀΐδης, meaning *unseen*. The English word hell had also originally the same meaning. It is derived from the Teutonic base *hal*, whence also the Anglo-Saxon *helan*, to hide, "so that the original sense is the hidden or unseen place" (Skeat).

The conception of future existence which lays claim to the greatest antiquity is that of the ancient Egyptians. According to the Egyptian belief, if the great judgment resulted adversely, "the condemned soul is either scourged back to the earth straightway, to live again in the form of a vile animal, as some of the emblems appear to denote; or plunged into the tortures of a horrid hell of fire and devils below, as numerous engravings set forth; or driven into the atmosphere, to be vexed and tossed by tempests, violently whirled in blasts and clouds, till its sins are expiated, and another probation granted through a renewed existence in human form." * In his description of the Ritual of the Dead, Renouf † mentions chapters in that book intended to secure the soul against dangers in the nether world, such as having his head cut off, dying the second death, suffering corruption, being turned away from his house, going to the *nemmat* (an infernal block for the execution of the wicked), going headlong into the *cherti-nutar*, and eating or drinking filth. Various divinities are invoked to save the soul from that god who feeds upon the accursed, from that god who seizes upon souls, devours hearts, and feeds upon carcasses. These perils which the good escape, says Renouf, sufficiently show the fate which the wicked must expect.

From Persia, also, we get a religion of great antiquity—Zoroastrianism—which, in a modified form, is held to-day by the small

* William R. Alger, A Critical History of the Doctrine of a Future Life, tenth edition, 1878, p. 103.

† The Religion of Ancient Egypt.

body of Parsis still to be found in Persia and India. According to the Parsi belief, the good after death pass safely over the bridge Chinevat, which stretches from Mount Alborj up to Garotman, the blissful realm of Ormuzd; while the wicked fall from the bridge into the Gulf of Duzahk, which yawns beneath, where they are tormented by dævas. At the end of the world, a comet will fall upon the earth, causing a vast conflagration, by which the whole earth will be melted, and the molten stream will pour down into Duzahk, carrying with it the sinners who are on earth at the time. Here they and the earlier comers, except those already redeemed by the prayers of friends, will burn for three days and nights and then thus purified will be received into heaven. Afterward all the dævas, and even the arch-fiend Ahriman, will have their evil burned away and will also enter the abode of light.

The Laws of Manu, one of the early sacred books of Brahmanism, names twenty-one hells. Punishments for different sins are, to be reborn into one of these hells, or to return to earth as a beggar, cripple, or leper, or in the form of a rat, a snake, or a louse, the penalty being in each case appropriate to the crime. Punishment need not be endless for any one, as each successive life is a new probation, in which righteousness wins admission to a higher stage of existence.

In Buddhism, which is one of the religions of China, and the state religion of Thibet and other countries of eastern Asia, future punishment is provided for in a great hell, comprising a system of one hundred and thirty-six lesser hells. The torments of these hells are depicted in many Buddhist books and paintings, with much detail and vividness.

The punishments recorded in the Jade Record and other works on future torment give frightful pictures of the torture of bad men; in many Buddhist temples these are represented by small figures, and in others by life-size images. Men are ground to powder, the dust becoming ants, fleas, and lice; pestled in a mortar, and mashed to jelly in iron mortars; chopped in slices with a knife and hacked to pieces with hatchets; the tongue of deceit and lying pulled out; sawn asunder; the bones and flesh crushed by falling mountains; women cast into a lake of blood; crossing the narrow bridge and falling among fiery serpents; the caldron of oil for those who waste rice; drunkards with the cangue and standing on the hands; quack doctors with hands and feet tied, and a large stone on the back, the fierce judge administering hot drinks; a man going into the mill head foremost, with the legs sticking out, and a dog coming out below in the transmigration; a headless ghost pulling his murderer to judgment; disemboweled, tossed on a hill of knives; cast on a lake of ice; chained to a red-hot cylinder; iron dungeon, darkness within and fire without; lashed with burning iron wires; when thirsty, drinking molten iron; eating red-hot iron balls; besides, there is the freezing hell, the burning hell, and the hell of bubbling filth.*

* The Dragon, Image, and Demon, by the Rev. Hampden C. Du Bose, pp. 311–313.

As for the two other religions of China, Confucianism tells nothing whatever about punishment after this life, while Taouism has a theory of retribution much like that of Brahmanism.

The Jews in Old Testament times had no idea of a hell. There is no mention of punishment after death in the teachings of Moses, nor is this doctrine taught by the prophets. The word *sheol*, which is translated by hell in the King James version of the Bible, meant simply the abode of the dead, and corresponded to the Greek *hades*, used in the New Testament and other Greek writings. Gloomy and repulsive ideas were associated with sheol, similar to those we connect with death and the grave, but it was the destination of good and bad alike, and not a place of punishment.* The troubles which the wicked and the enemies of the Jews were threatened with by the prophets pertained to this world. They were pain, disease, loss of possessions and kindred, hostility of neighbors, death, and indignities to the dead body. The idea of sheol first became modified after the Persian captivity. The place was divided into two parts, which were separated only by the width of a thread. One of these divisions was for the good, awaiting resurrection, and was called Paradise; the other, set apart for the wicked, was called Gehenna. This latter designation means "the valley of the son of Hinnom," and was originally the name of a gorge outside of Jerusalem in which the Jews had practiced the fiery worship of Moloch, and where afterward offal from the city and the bodies of criminals were thrown, to be consumed by the fires always kept burning there. The idea of Gehenna as a place of future punishment had appeared in rabbinical theology and become quite detailed a century or more before Christ. Hell was represented as having special apartments for different kinds of torment. One place, from its darkness, was called "Night of Horrors." The fire of Gehenna was said to have been kindled on the evening of the first Sabbath, and would never be extinguished.† A Talmudic writer, quoted by Alger,‡ says: "There are in hell seven abodes, in each abode seven thousand caverns, in each cavern seven thousand clefts, in each cleft seven thousand scorpions; each scorpion has seven limbs, and on each limb are seven thousand barrels of gall. There are also in hell seven rivers of rankest poison, so deadly that if one touches it he bursts."

At the coming of Christ, there were three chief sects among the Jews. The Pharisees, who were by far the most numerous, believed that sinners were kept forever in a prison in the underworld; the Essenes believed that the vicious suffered eternal pun-

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* Schaff-Herzog, Encyclopædia of Religious Knowledge, article Hell.

‡ Basnage, History of the Jews, lib. iv, cap. 30. † Future Life, p. 509.

ishment in a dark, cold place; and the Sadducees thought that the soul died with the body. The first threats of hell in the Scriptures occur in the teachings of Jesus. There are three words in the New Testament which were translated by hell in the King James Bible: *hades*, meaning the same as elsewhere in Greek literature; *Gehenna*, which was properly the hell of Hebrew conception, and is uniformly so rendered in the revised version; and *Tartarus*, used only once (2 Peter, iii, 4), which is the regular Greek word for the place of punishment after death.* The place of future punishment represented in Christ's teachings is a region of fire: "Whosoever shall say, Thou fool, shall be in danger of the hell of fire" (Matt. v, 22, revised version); the fire is to be eternal and unquenchable: "It is good for thee to enter into life maimed, rather than having thy two hands to go into hell, into the unquenchable fire, . . . where their worm dieth not, and the fire is not quenched" (Mark ix, 43, 48; see also Matt. xviii, 8). In Revelation" St. John informs us what fuel is to support the unquenchable fire: "If any man worshipeth the beast and his image, . . . he shall be tormented with fire and brimstone in the presence of the holy angels, and in the presence of the Lamb: and the smoke of their torment goeth up forever and ever; and they have no rest day and night" (Rev. xiv, 9–11). In another passage it is revealed concerning various kinds of sinners that "their part shall be in the lake that burneth with fire and brimstone: which is the second death" (Rev. xxi, 8). This doctrine was intended to last unchanged for all time, for we find in the last chapter the statement that, if any man shall add to or take from the words of this book, he shall suffer all the torments and lose all the rewards which are written in this prophecy (Rev. xxii, 18, 19).

The religion of Islam is characterized by lack of originality, and the Mohammedan hell contains nothing but easily made variations of the Gehenna of the Jews. To the man that disobeys the precepts of the Koran it is promised that "God shall cast him into hell-fire; he shall remain therein forever."† Further it is written: "Verily, those who disbelieve our signs, we will surely cast to be broiled in hell-fire; so often as their skins shall be well burned, we will give them other skins in exchange, that they may taste the sharper torment, for God is mighty and wise" (chapter iv). The physical pain of fire, applied in various ways, is also the staple of the following torments: "They who believe not shall have garments of fire fitted to them; boiling water shall be poured on their heads; their bowels shall be dissolved thereby, and also their skins; and they shall be beaten with maces of iron" (chap-

* Schaff-Herzog, ibid., idem.

† The Koran, Sale's translation, chapter iv.

ter xxii). Those men who are sent to the left hand on the judgment-day "shall dwell amid burning winds and scalding water, under the shade of a black smoke, neither cool nor agreeable." Ye "shall surely eat of the fruit of the tree of *al-Zakkum*,* and shall fill your bellies therewith; and ye shall drink there only boiling water."

In the Greek mythology, which was copied by the Romans, the place of future punishment is called Tartarus. The universe is represented in the poetry of Homer and Hesiod as a hollow globe, divided by the flat earth. In the top of the upper hemisphere was Olympus, the home of the gods; in the hemisphere beneath the earth was hades, the abode of all the dead; and in its lowest depths was Tartarus. An anvil would be nine days and nights in falling from Olympus to the earth; nine days and nights from the earth to the bottom of Tartarus. "Around it, moreover, a brazen fence has been forged; and about it Night is poured in three rows."† In Tartarus there is darkness, and the air has no motion. It was at this time regarded as the place of punishment for the Titans, who had rebelled against the powers of Olympus. Later the poets began to speak of mortals who had offended the gods, or had been unjust to their fellow-men, being sent there after death. Prometheus, who was guilty of overreaching Zeus, was punished by being chained to a rock, part of the time on earth and part in Tartarus. An eagle devoured his liver every day, and it was renewed every night.‡ Ixion, who had been treacherous to Zeus, was chained by the hands and feet to a wheel, which is described as winged or fiery, and said to have rolled perpetually in the air. He is further said to have been scourged and compelled to exclaim, "Benefactors should be honored."‡

Sisyphus is represented by different authors as guilty of treachery of various kinds. "His wickedness during life was severely punished in the lower world, where he had to roll up hill a huge marble block, which, as soon as it reached the top, always rolled down again."‡ Tantalus was a wealthy king, who divulged the secrets of Zeus. "The gods punished him by placing him in the nether world in the midst of a lake, but rendering it impossible for him to drink when he was thirsty, the water always withdrawing when he stooped. Branches laden with fruit, moreover, hung over his head, but when he stretched out his hand to reach the fruit the branches withdrew. Over his head there was suspended a huge rock, ever threatening to crush him."‡ The Danaides, or fifty daughters of Danaus, all but one of whom in

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* A thorny tree with a fruit like an almond, but extremely bitter (Sale).

† Hesiod, Theogony.

‡ Smith, Dictionary of Greek and Roman Biography and Mythology.

obedience to their father killed their husbands on their wedding-night, were punished in Tartarus by being compelled everlastingly to pour water into a sieve.

The idea of Tartarus becomes more definite in later classical writings. Hades was divided into Elysium, or the region of dawn, which was the abode of the good, and Tartarus, the region of night, which was the destination of the wicked. Virgil describes Tartarus in telling of the descent of Æneas to the under-world to visit his father (Æneid, vi, 548–627). It is in the form of a prison, inclosed with a triple wall. Phlegethon, a flaming torrent, rushes by the walls, whirling great rocks along in its course. The huge gate is swung between columns of adamant and from an iron tower. Tisiphone, with her bloody robe tucked up around her, watches the vestibule night and day. The great chasm is twice as deep as from earth up to heaven. Groans are heard issuing from the place, and the strokes of cruel lashes, the grating of iron, and the clanking of chains. Rhadamanthus judges the spirits on their arrival, and they are then turned over to the Furies for appropriate punishments, of which the torments of Ixion, Sisyphus, and a few others are given as examples.

According to the Scandinavian mythology, all who die bravely in battle are snatched away to Valhalla, Odin's magnificent banquet-hall in the sky. Those who, after lives of ignoble labor or inglorious ease, die of sickness, descend to a cold and dismal cavern beneath the ground, called Niflheim—i. e., the mist-world. This abode is ruled by the goddess of death, whose name is Hel. The place of torment for reprobates is Nastrond, deeper underground than Niflheim, and far toward the frigid north. This grim prison is described in the following passage from the Prose Edda, written in Iceland in the thirteenth century: "In Nastrond there is a vast and direful structure with doors that face the north. It is formed entirely of the backs of serpents, wattled together like wicker-work. But the serpents' heads are turned toward the inside of the hall, and continually vomit forth floods of venom, in which wade all those who commit murder or who forswear themselves."* According to the Voluspa, a poem of earlier date, the evil-doers in Nastrond are also gnawed by the dragon Nidhögg.

The fathers of the Christian Church generally taught the existence of a hell of material fire and brimstone. Alger† gives as their belief that at the resurrection the damned "were to be banished forever to a fiery hell in the center of the earth, there to endure uncomprehended agonies, both physical and spiritual, without any respite, without any end." The strict literality with which these doctrines were held is strikingly shown in Jerome's

* Prose Edda, chapter lii.

† Future Life, p. 402.

artless question: "If the dead be not raised with flesh and bones, how can the damned, after the judgment, *gnash their teeth* in hell?" "Origen, who was a Platonist, and a heretic on many points," says Alger,* "was severely condemned for saying that the fire of hell was inward and of the conscience rather than outward and of the body." Tertullian says, "The damned burn eternally without consuming, as the volcanoes, which are vents from the stored subterranean fire of hell, burn forever without wasting."† These words point also to the belief, noted above, that hell was located under the earth.

In the middle ages the Christian conception of hell became more detailed and more terrible. The details can be found not only in the books of the period, but they were favorite subjects for miracle-plays and for works of art, especially for the pictures, carvings, and painted windows with which cathedrals were adorned. The monks of the period produced an extensive literature of visions describing the torments of hell. In these visions, according to Lecky—

> The devil was represented bound by red-hot chains on a burning gridiron in the center of hell. The screams of his never-ending agony made its rafters to resound; but his hands were free, and with these he seized the lost souls, crushed them like grapes against his teeth, and then drew them by his breath down the fiery cavern of his throat. Demons with hooks of red-hot iron plunged souls alternately into fire and ice. Some of the lost were hung up by their tongues, others were sawn asunder, others gnawed by serpents, others beaten together on an anvil and welded into a single mass, others boiled and then *strained* through a cloth, others twined in the embraces of demons whose limbs were of flame. The fire of earth, it was said, was but a picture of that of hell. The latter was so immeasurably more intense that it alone could be called real.‡

By far the most elaborate description of the punishments of sinners which the middle ages produced is that of Dante, whose Inferno combines the torments of the classical Tartarus and the horrors of the Christian hell. In this poem, which was written about 1300, the author represents himself as being conducted through the infernal regions by Virgil. Within the gates of hell, but before crossing the river Acheron, the visitors found those who had lived "withouten infamy or praise," and angels who had been neither faithful nor rebellious, but only selfish. They "were naked and were stung exceedingly by gad-flies and by hornets that were there."§ Beyond Acheron were found the great ones of old, whose sin was lack of baptism. These were "only so far punished that without hope we live on in desire" (iv, 41, 42). In the third circle, rain, snow, and hail constantly poured down

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* Future Life, p. 516. † Apologia, cap. 47, 48.

‡ History of European Morals, vol. ii, pp. 235, 236.

§ Divine Comedy: Inferno, Canto III, lines 65, 66, Longfellow's translation.

upon the miry earth (vi, 10–12)—a truly dismal abode. Further on a group of the damned are confined in tombs made as hot by flames as iron need be for any art. Whenever a soul is cast into another circle it sprouts like a seed, and grows into a tree. The Harpies then cause it pain by feeding upon its leaves (xiii, 99–102). Soon a drove of sinners was met, followed by "horned demons, with great scourges, who cruelly were beating them behind" (xviii, 35, 36). In one place were a lot of holes in the rocky floor, in each of which a transgressor was stuck head downward, and as far as the calf, while the soles of his feet were frying with a greasy flame (xix, 13–30). In another place was a lake of boiling pitch in which souls were immersed, while demons stood round and kept them under the surface with gaffs (xxi, 16–57). Another group of lost ones had their hands bound with serpents, which were also biting and stinging their bodies (xxiv, 94–96). Others were driven round a ring, where each time they passed a devil would cut them open so that their bowels hung out, and the wound would close again while they were making the next circuit (xxviii, 22–42). In one of the inner circles, if from the hospitals, "all the diseases in one moat were gathered, such was it here, and such a stench came from it, as from putrescent limbs is wont to issue" (xxix, 49–51). Its denizens were scratching scabs from their sores as a knife takes the scales off a fish.

The punishments increase in severity with the descent to the inner and smaller circles of the vast amphitheatre. In the ninth and last circle, where traitors are punished, there is an ice-bound lake, into which the perfidious ones are frozen. "The emperor of the kingdom dolorous from his mid-breast forth issued from the ice." He is supergigantic in size, and has three faces on his head. In each mouth he crunches a sinner, but "To him in front the biting was as naught unto the clawing, for sometimes the spine utterly stripped of all the skin remained" (xxxiv, 55–60). The three arch-traitors distinguished by these supreme torments were Brutus, Cassius, and, the one in front, Judas.

The reformers made little change in the mediæval conception of hell. Calvin writes: "Forever harassed by a dreadful tempest, they shall feel themselves torn asunder by an angry God and transfixed and penetrated by mortal stings, terrified by the thunderbolts of God, and broken by the weight of his hand, so that to sink into any gulfs would be more tolerable than to stand for a moment in these terrors."

The characteristic austerity of the Puritans finds free scope in the depiction of hell's torments. Their great poet Milton describes the place in the first and second books of Paradise Lost. Satan and his host are cast into it "there to dwell in adamantine chains and penal fire."

"A dungeon horrible, on all sides round,
As one great furnace flamed; yet from those flames
No light, but rather darkness visible" (i, 61–63).

It is swept by "a fiery deluge, fed with ever-burning sulphur unconsumed." Besides a burning lake, it contains land or "firm brimstone"—that is, "if it were land that ever burned with solid, as the lake with liquid fire." From a hill on this land is dug ore of gold and other metals, which furnish the building materials for the magnificent palace Pandemonium, the high capital of Satan and his peers. In the second book are mentioned "four infernal rivers, that disgorge into the burning lake their baleful streams." Far away was Lethe, the river of oblivion, and "beyond this flood a frozen continent lies dark and wild, beat with perpetual storms of whirlwind and dire hail." Thither at intervals all the damned are brought to be tormented by extremes of heat and cold (ii, 597–601). When Satan, starting out to discover the earth, reaches the bounds of hell, he finds "thrice threefold the gates—three folds were brass, three iron, three of adamantine rock; impenetrable, impaled with circling fire, yet unconsumed."

The teaching of the Church of England in Milton's time did not differ much from that of the Dissenters. Jeremy Taylor devotes two chapters to deliberately recounting the most atrocious cruelties recorded in history, and asserts that they will be surpassed by the tortures in store for the wicked. A few instances will suffice:

Alexander, the son of Hyrcanus, caused eight hundred to be crucified, and while they were yet alive caused their wives and children to be murdered before their eyes, that so they might not die once, but many deaths. This rigor shall not be wanting in hell. . . . Mezentius tied a living body to the dead until the putrefied exhalations of the dead had killed the living. . . . What is this in respect of hell, when each body of the damned is more loathsome and unsavory than a million of dead dogs? . . . We are amazed to think of the inhumanity of Phalaris, who roasted men alive in his brazen bull. That was a joy in respect of that fire of hell. . . . The torment . . . comprises as many torments as the body of man has joints, sinews, arteries, etc., being caused by that penetrating and real fire of which this temporal fire is but a painted fire.*

The Puritans in America were no less emphatic in their depictions of hell than the parent stock in England. Many are the passages in the sermons of that stanch New England divine, Jonathan Edwards, devoted to setting forth the agonies of eternal punishment. The following extract is typical not only of Edwards, but also of his contemporaries:

Imagine yourself to be cast into a fiery oven, or a great furnace, where your pain would be as much greater than that occasioned by accidentally touching a

* Contemplations on the State of Man, Book II, chapters vi, vii.

coal of fire as the heat is greater. Imagine also that your body were to lie there for a quarter of an hour, full of fire, and all the while full of quick sense; what horror would you feel at the entrance of such a furnace! and how long would that quarter of an hour seem to you! And, after you had endured it for one minute, how overbearing would it be to you to think that you had to endure it the other fourteen! But what would be the effect on your soul if you knew you must lie there, enduring that torment to the full, for twenty-four hours! And how much greater would be the effect if you knew you must endure it for a whole year! And how vastly greater still if you knew you must endure it for a thousand years! Oh, then, how would your hearts sink if you knew that you must bear it for ever and ever!—that there would be no end!—that, after millions of millions of ages, your torment would be no nearer to an end, and that you never, never should be delivered! But your torment in hell will be immensely greater than this illustration represents.*

Among primitive peoples in various parts of the world, a variety of notions in regard to future punishment have prevailed. The African tribes which have not been affected by Mohammedan or Christian influence, although they may believe in future rewards and punishments, generally have no idea of definite places for heaven and hell. The Kamtchadales also have no hell. Of the American peoples, the ancient Mexicans affirmed that the wicked went to Mictlan, a dismal cavern within the earth. The Peruvian hell was also in the earth, and there the reprobate must endure centuries of toil and anguish. The Eskimo believe that hell is among the rocks, ice, monsters, and chilling waters of the sea. All souls must go down into it, but the good pass deeper to a more peaceful abode. The American Indians have no idea of a place of future torment except where it has been derived from white missionaries. "The typical belief of the tribes of the United States," says Brinton,† "was well expressed in the reply of Esau Hajo, great medal chief and speaker for the Creek Nation in the National Council, to the question, Do the red people believe in a future state of rewards and punishments? 'We have an opinion that those who have behaved well are taken under the care of Esaugetuh Emisee, and assisted; and that those who have behaved ill are left to shift for themselves; and that there is no other punishment.'"

No writer since ancient Egyptian times has given such a detailed theory of the future life as Swedenborg. In his book on Heaven and Hell, originally published in 1758, he says that punishments in hell are manifold; the more cunning and malignant of the damned domineer over the simpler. The faces of those in hell are deathly and dreadful: some are black, some fiery, some disfigured with pimples, warts, and ulcers; some have no face, only a hairy or bony surface. The "infernal heat is turned into

* Jonathan Edwards's Works, vol. vi, p. 99. † The Myths of the New World.

intense cold when heat from heaven flows in, and then the infernal inhabitants shiver like those who are seized with a cold fever." The hells are everywhere—under mountains, rocks, plains, and valleys. In the milder hells there appear to be cities of rude huts; in the huts are infernal spirits, engaged in continual quarrels, enmities, blows, and fightings; in the streets and lanes robberies and depredations are committed. In other hells there are forests, or deserts, or ragged rocks, or ruins as of burned cities.

Christian preachers and writers of the present time do not agree as to the nature of hell's torments. Many of them are coming to attach a figurative meaning to the biblical descriptions of hell, and seem as loath as their predecessors were eager to dwell upon the subject. In the Fortnightly Review for January, 1876, Lionel A. Tollemache says, "The wiser among us are seeking to drop hell out of the Bible as quietly, and about as logically, as we already contrive to disregard the plain texts forbidding Christians to go to law, and Christian women to cut their hair." Canon Farrar, in a series of sermons, has emphatically declared his disbelief in a hell of material and everlasting fire.

That widely known book Letters from Hell describes the place of torment as a country where the wicked are impelled to continually follow the same pursuits as in life; whatever they wish for is at once provided, amusements of all sorts are indulged in, but everything is empty and unreal, they are possessed by a constant hunger for pleasure which is never satisfied, tormented by memories of their lives on earth, driven from one thing to another to escape threatened misery, always on the verge of despair, and never by their feverish activity achieving even forgetfulness.

The Roman Catholic Church now, as always, holds that there are material torments in hell. The idea of hell which prevailed in Europe in the middle ages was that taught by the Catholic Church, which was practically the only form of Christianity at that time. An extremely realistic picture of hell is drawn in a Catholic tract, by the Rev. J. Furniss, C. S. S. R., published not long ago, with high ecclesiastical indorsement, "for children and young persons" in England and America. It is entitled The Sight of Hell, and describes little children turning and twisting in red-hot ovens, and screaming to come out.

The following statement of Catholic doctrine concerning hell is abridged from A Catholic Dictionary, by Addis and Arnold. Hell may be defined as the place and state in which the devils and such human beings as die in enmity with God suffer eternal torments. Theologians divide the punishments of the damned into that of loss and that of sense. The former is the deprivation of the vision of God. The devils and disembodied spirits of the damned suffer from material fire. The lost are afflicted also by

"the worm which never dies"—i. e., by the anguish of remorse; they are doomed to endure the society of others reprobate like themselves, and they know that all hope is over. After the resurrection the body also is subject to torment. It is certain that hell is a definite place, but uncertain where. Many of the fathers and theologians have held that it is in the center of the earth. Origen and some who followed him have thought that the punishment of the wicked would not be eternal, but a council has defined that the punishment of hell lasts forever.

Mr. C. H. Spurgeon, the celebrated English Baptist, says, in a sermon on The Resurrection of the Dead:

> There is a real fire in hell—a fire exactly like that which we have on earth, except that it will torture without consuming. When thou diest thy soul will be tormented alone in hell; but at the day of judgment thy body shall join thy soul, and then thou wilt have twin hells, body and soul together, each brimful of pain; thy soul sweating in its inmost pores drops of blood, and thy body, from head to foot, suffused with agony; not only conscience, judgment, memory, all tormented, but thy head tormented with racking pain, thine eyes starting from their sockets with sights of blood and woe; thine ears tormented with horrid noises; thy heart beating high with fever; thy pulse rattling at an enormous rate in agony; thy limbs cracking in the fire, and yet unburned; thyself put in a vessel of hot oil, pained, yet undestroyed.

Heine's Reisebilder contains a witty caricature of the orthodox hell, in which his satirical genius has free play.

The Presbyterian Confession of Faith teaches that the punishment of sin shall be separation from God, "and most grievous torments of soul and body, without intermission, in hell-fire forever."

That Unknown Country, a large octavo volume published in 1889, contains fifty chapters, each contributed by a living theologian as his views concerning punishment after death. These statements contain little description of the torments of hell; they are devoted mainly to discussing whether or no any of the condemned can shorten their term of punishment by repentance after death, and whether hell may not end with either the final salvation or annihilation of all the wicked. In this book Bishop Fowler, of the Methodist Episcopal Church, says that the popular conception of hell should be freed from the physical flames to be correct. Rev. Chauncey Giles (Swedenborgian) compares hell to an asylum for the incurably insane. Rev. Edward Everett Hale says, "No Unitarian supposes that life after death is limited in any way, so that one place in the universe can be mapped off as heaven, and another place mapped off as hell." Dr. A. A. Miner (Universalist) maintains that "punishment after death for the sins of this life is not taught in the Word of God." C. W. Pritchard, minister in the Friends' Church, Chicago, says, "Heaven is

a *place*, and hades is a *place*," and calls the modern idea of hell a "mystical, superspiritual view." Mr. Talmage, of Brooklyn (Presbyterian), asks: "What is the use of explaining away a furnace of fire, when God says there is one? . . . I am not opposed to saying it may be figurative; but I know very well that if it is not fire it is something as severe as fire. . . . God says it is fire, and a furnace of fire. Besides that, I do not know that it is figurative. It may be literal. The Bible sixteen times says it is fire." Dr. H. W. Thomas, pastor of the People's Church, Chicago, says that there is now a tacit admission on the part of even the orthodox churches that "the teachings of the past on this subject are not wholly true, and that, in some respects at least, they have to be modified or abandoned."

"The proprietor of a great foundry in Germany," says Alger, "while he talked one day with a workman who was feeding a furnace, accidentally stepped back, and fell headlong into a vat of molten iron. The thought of what happened then horrifies the imagination. Yet it was all over in two or three seconds. Multiply the individual instance by unnumbered millions, stretch the agony to temporal infinity, and we confront the orthodox idea of hell."* Mr. Alger maintains that the doctrine of a local hell, a guarded and smoking dungeon of the damned, ought not to be regarded as a truth contained in a revelation from God, because it is plainly proved by historic evidence to be a part of the mythology of the world, a natural product of the poetic imagination of ignorant and superstitious men.†

THE DISCOVERY OF INVISIBLE WORLDS.

By Dr. KLEIN.

SOME discoveries have very recently been made in the starry heavens which must be regarded, not only in what they are of themselves, but also on account of the way in which they were made, as among the most interesting of scientific events. It seems, in fact, like a contradiction to say that astronomers in Europe and America have been able to determine the velocity of motion, size, and weight of stars that are not visible in any telescope, and which no telescope to be made in the future, no matter how great its power may be, will be able to show. The new science also has the peculiar property that it recognizes mutual relations between objects apparently lying far from one another, connects with one another phenomena which appear to have no com-

* Future Life, preface to the tenth edition. † Future Life, p. 699.

mon measure, and draws fine lines of connection between earth and sky. One of these lines was drawn some thirty years ago in spectrum analysis; and by its aid man has risen in mind to remote worlds, and has sounded their physical and chemical constitution. The same spectrum analysis has now again celebrated a great triumph—a victory which might have been predicted, but the time for which did not seem yet to have come.

Every one is acquainted with the spectrum which we see when a ray of sunlight coming through a narrow opening passes through a prism. With the aid of suitable instruments there can also be seen in this spectrum a considerable number of dark cross-lines; and science has shown that these lines are caused by the presence of certain simple bodies or elements, including iron, hydrogen, sodium, etc. When we examine the light of the stars through those instruments, we shall perceive that in their spectrums too the dark lines denoting these elements are present. On this is founded the chemistry of the stars, for which we are wholly indebted to spectrum analysis. The situation of the dark lines in the spectrum is unchangeable, or else we would not be able to conclude from it respecting the elements represented there. The unchangeable character persists, however, only when the source of light is at rest as to the observer. If the shining body we are regarding is going away from us very rapidly, the dark lines incline to shift themselves slightly toward the red end of the spectrum; while, if it is approaching us with great rapidity, they slide over toward the violet. Without stopping to explain the causes of the shifting, we may remark that it is very small even with the greatest velocities. Former observers could hardly recognize it with certainty, because their instruments were not delicate enough to reveal such slight changes. Gradually makers have succeeded in constructing instruments that will show the changes with certainty. At the Greenwich Observatory, where observations of this kind have been carried on for several years, the motions in space of several stars have been ascertained with the help of the spectroscope. It has thus been found that the clear-shining Capella is receding from the earth at the rate of twenty-seven English miles a second, and that the brilliant star Vega in Lyra is approaching us at the rate of thirty-four miles a second. As such observations deal with infinitesimally small magnitudes, they are necessarily very difficult and precarious. It has been found, by investigations at the Astrophysical Observatory in Potsdam, that much more certain results are obtained if the spectrums of the stars are photographed and the measurements of the lines are made afterward on the pictures. These results have been confirmed by spectro-photographic researches at the Cambridge Observatory in North America; and thus the spectrographic method justifies the great-

est hopes. With this explanation we are prepared to understand the important discoveries that have been made at Potsdam and Cambridge.

The bright star Mizar in the Great Bear is known to all. It is resolved in the telescope into two stars, the bright star being accompanied by a dimmer one, which is evidently a satellite, but possesses a period of revolution of about two thousand years. The spectrum of the principal star has been photographed several times since 1887 at the Cambridge Observatory, Mass., and the photographs have been carefully studied by Miss A. C. Maury, a niece of the celebrated Dr. Draper. The curious fact has been brought out that one of the photographed dark lines appears, at times, as if it was split into two fine lines. The doubling appears in the photographs of May 29, 1887, and of May 17 and 27, and August 28, 1889. In other photographs the lines appear washed out, as if they consisted of two lines, yet not quite separated; while on still others they appear clearly defined. On making up the registers of the times when the lines presented their different appearances, it was found that they appeared double at intervals of fifty-two days, washed out a few days before and afterward, and at other times single and sharp. By way of test the time was predicted when they should appear double again, and they came so, true to the forecast. The other lines in the spectrum of Mizar are not very sharp, and some of them are very faint. Careful examinations have shown that those few sharp lines also appear somewhat washed and broader when the first line is doubled, while the faint lines are at the same time very hard to see. The explanation of these variations, according to Prof. Pickering, Director of the Cambridge Observatory, lies in the supposition that the chief star Mizar is itself a double star, whose components revolve around one another in one hundred and four days, but are still so close together that no telescope can separate them. They appear even in the most powerful telescope only as a single round star. When one of the two stars is moving toward the earth, all the lines in its spectrum are pushed toward the blue end; at the same time the second star, since both participate in the revolution, must be receding from the earth, and the lines of its spectrum are pushed toward the red end. As soon, again, as the motion of the stars is perpendicular to a line drawn to the earth, all the lines will have their normal position, and mutually cover one another; they will appear single and distinct. The amount of the motion is calculated, from the extent of the doubling, at a hundred English miles in a second; from the period of revolution of one hundred and four days, the circumference of the orbit is deduced to be 900,000,000 English miles, and the distance of the two stars apart 143,000,000 miles, or about the distance of the planet Mars from the sun. The

period of revolution of Mars is six hundred and eighty-seven days, and would be less if the mass or weight of our sun was greater. We can hence calculate how many times greater than the mass of the sun must be the mass of the two stars of Mizar for the revolution to be accomplished in one hundred and four days. The result is forty times the mass of the sun. So this little point of light which Mizar in the Great Bear appears to the eye is the equivalent of forty of our suns.

Before the news of this astonishing discovery made at Cambridge had reached Europe, a similar investigation made at the Potsdam Observatory was published. It was directed to the star Algol in the head of Medusa. This star has been known for more than two hundred years to be variable in brightness. It shines for two days and a half with a steady white light, then loses brightness for about four hours and a half, recovers during about four hours and a half, and then continues steady again for two days and a half. The changes go on with great regularity, and it has been believed for the last hundred years that Algol is attended by a double star revolving around it, by which it is concealed from the earth at regular intervals, depending on the period of its revolution. The periodical decrease of brilliancy is similar in its nature and cause to an eclipse of the sun, when the dark moon is interposed between it and the earth. But probable as this belief was, the fact had not been demonstrated. A complete solution has been obtained by spectrum analysis. Prof. Vogel, of the Astrophysical Observatory in Potsdam, and his fellow-worker, Dr. Scheiner, have taken photographs of the spectrum of Algol and carefully measured the dark lines. It has thus been ascertained that these lines move toward the red before the star appears at its weakest, toward the violet after that moment; or, in other words, that Algol is receding from the sun in the first half of its change, approaching it in the second half. This would necessarily occur if the star was describing an orbit around a dark body which should periodically conceal it for a time from our view. The rate of motion of Algol is twenty-three English miles in a second, and its period of revolution is two days, twenty hours, and forty-nine minutes; whence the circumference of its orbit and the distance apart of the centers of the two stars may be computed as was done in the case of Mizar. The latter is found to be less than 3,000,000 English miles, a small enough distance for two so large bodies. From the period of the light-changes and the velocity of the motion we calculate the diameter of the principal star to be 920,000 and of its dark companion 750,000 English miles. The two bodies which form the Algol system are each nearly as large as our sun, the diameter of the sun being taken at 750,000 miles, but their total mass is only about two thirds the mass of

the sun. We have, says Prof. Vogel, to think of these two bodies as surrounded by extensive atmospheres, and that that of the principal body, or Algol itself especially, must possess considerable illuminating power. Under certain presuppositions, the height of this atmosphere is estimated at 216,000 English miles, and that of the atmosphere of its dark companion at 168,000 miles. The smallest interval between the atmospheres of the two bodies will thus be 1,600,000 English miles, or less than can be found in our solar system. It is not easy, as Prof. Vogel suggests, to conceive two bodies so near of nearly equal size, one of which is in the highest glow of heat, and the other in a condition of far-advanced cooling. But the facts of observation lead to this conclusion, and in science facts constitute the highest and ultimate authority, before which everything must yield. Thus, we learn from the remarkable discoveries in Potsdam and Cambridge that the world-order we meet in our solar system does not reign throughout the kingdom of the fixed stars, but that other relations come in which are quite different from those under which we live.—*Translated for the Popular Science Monthly from Daheim.*

EVOLUTION AND THE DISTRIBUTION OF ANIMALS.*

By DAVID STARR JORDAN,
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II.

I was lately called to examine a specially interesting problem in geographical distribution, that of the dispersion of fishes in the Yellowstone Park. This region is a high volcanic plateau, formed by the filling of a mountain basin with a vast deposit of lava. The streams of the park are for the most part among the coldest and clearest of the Rocky Mountains, and apparently in every way suitable for the growth of trout. All the hot springs of the great Geyser basin are not sufficient to warm the waters of the Fire-hole River. Yet, with the exception of the Yellowstone itself, all these streams are destitute of fish-life. A reason for this is apparent in the fact that the plateau is fringed with cataracts which no fish can ascend. Each stream has a cañon and waterfall near the point where it exchanges the hard bed of lava for the softer rock below. So the best of trout-streams, for an area of fifteen hundred square miles, are left without trout, because their natural inhabitants can not get to them.

On the theory that each species occupies those places best

* An address delivered before the Chicago Institute, in a course on the Testimony of Science in regard to Evolution.

suited to its life, this fact would represent a great oversight on the part of Mother Nature. But with this is the curious fact that the Yellowstone itself, both above and below its falls, is well stocked with trout and with no other fish. This is an anomaly of distribution, but this anomaly disappears when we examine the continental divide as it appears at the head of the Yellowstone. At one point, the Two-Ocean Pass, only about an eighth of a mile of wet meadow and marsh separates the drainage of the Yellowstone from that of the Columbia. From the Columbia the Yellowstone has therefore received its trout. No doubt every anomaly of distribution would become perfectly simple could we only know all the facts which bear on the case.

In my studies of the fishes of America I have had occasion to especially investigate the barriers to their distribution, and the relative value of these as limiting the range of the different forms.

In general we may say that, with rare exceptions, in all waters not absolutely uninhabitable, there are fishes. The processes of natural selection have given to each kind of river or lake species of fishes adapted to the conditions of life which obtain there. There is no state of water, of bottom, of depth, of speed of current, but finds some species with characters adjusted to it. Each of these species has an ascertainable range of distribution, and within this range we may be reasonably certain to find it in any suitable waters.

But every species has beyond question some sort of limit to its distribution, some barrier which it has never passed in all the years of its existence. That this is true becomes evident when we compare the fauna of widely separated rivers. Thus the Sacramento, Hudson, St. Johns, and Rio Grande have not a single species common to any two of them. None of them has any species peculiar to itself, and each one shares the greater part of its fauna with the water-basins nearest to it.

With the shore fishes, as with other water animals, the barriers are primarily the heights of the land and the depths of the sea—physical obstacles not to be crossed. Next in importance is the barrier of climate. With some forms of life this is absolute, for the palm and the banana are the index of the torrid zone as the dwarf birch and reindeer moss are the index of the frigid. "Plants," says Dr. Gray, "are the thermometers of the ages by which climatic extremes and climates in general are best measured." In many groups anatomical characters are not more profound or of longer standing than are the adaptations to heat and cold. Heat-loving animals are far more numerous in species than animals of cold climates, though the latter often make up by greater abundance of individuals. Barriers less important

than those of climate arise from external surroundings—from absence of means of defense, from character of food, of air, of water, and the presence of various enemies. These conditions vary in their importance with each group of animals, yet apparently the least of them may be able to limit the range of species. To limit the range is the first step toward extinction, for to cease to advance is to retreat. Adverse conditions may invade even the heart of its distribution, causing reduction of numbers, which, if long continued, must mean rarity and final extermination. Extinction comes to those species we call rare, and its advent must be unnoticed. Circumstances become unfavorable to the growth or reproduction of some animal. Its numbers are reduced —it is rare—it is gone.

The air in Indiana but a few years since was dark with the hordes of passenger pigeons at the time of their fall migrations. The advance of a tree-destroying, pigeon-shooting civilization has gone steadily on, and now who has seen a passenger pigeon? I have seen them, and I have a skin or two in my collection, but the bird I knew as filling the trees in my boyhood is now in the same region an ornithological curiosity.

A very slight change in the environment of any species may be a matter of the greatest moment as regards its increase or permanence. The dependence of the clover on the number of cats in a certain neighborhood is an illustration given us by Mr. Darwin. The clover depends on the bumble-bee for the fertilization of its pods. The nests of the bumble-bee are destroyed by the field-mouse, which is thus an enemy of the clover. The balance is restored by the work of the cat, who captures the mouse and prevents its ravages on the nests of the bee. The old nursery jingle of the cow that tossed the dog that worried the cat that killed the rat is repeated throughout nature. With any change in any of the elements in this series the whole equilibrium of nature is interrupted. For this equilibrium is apparent only—a sort of armed neutrality, an established order of things which the superficial observer mistakes for real peace and permanence.

In some groups we find evidence of a progressive adaptation of individuals to circumstances—for example, to climate, ending in the formation of new species to accord with changed conditions of temperature. We may illustrate this by means of the arctic birches. In Norway, as in most northern regions with a moist climate, there are large forests of birches. In the valleys, where the summers are warm and reasonably long, the birches of different species grow to be considerable trees. Farther to the north, or higher up the mountains, the summer is too short for the growth of birch-trees, and their place is taken by birches which never pass beyond the size of small bushes. Still higher up there

are birches even where snow falls during every month of the year, and the distant sun gives only a glimpse of summer in July. Competition with other plants is, of course, not severe in such regions, but the birches must struggle against the weather. They can live and multiply, if only they can adjust themselves to the conditions of life. They must keep down their size, they must carry as little foliage as possible, and their stems must be tough enough to resist snow, and hardy enough to withstand almost perpetual frost. Their year's growth must be finished in a very short time, and leaves, flowers, and seeds must follow in the most rapid succession. In short, there is room for birch-trees here, if only the trees can be reduced to their lowest terms. And so birch-trees have crept up the mountain-sides even to the very edges of the perpetual snow. But such trees! All trees requiring sunshine, or long time for their summer's growth, are rigidly kept away by "natural selection." The cold climate dwarfs the individual, and the hard conditions exclude every individual not dwarfed. I have before me three birch-trees from a Norwegian mountain called the Suletind—the little trees known to the Norwegian peasants as "Hundsöire," or "dogs'-ears." The trunk of each tree is barely an inch in height. There are no branches, and but three leaves. Half inclosed by the uppermost leaf is the single little catkin of flowers. Leaves in June, blossoms in July, fruit in August, and then the little tree is ready for its nine months' sleep. These little trees are the Lapps of forest vegetation.

All natural history is full of similar cases of modifications. Everywhere there is the most perfect adaptation of life to its conditions. But this adaptation must come about through the survival of those organisms fittest to live under the conditions, while the unfit die out and leave no progeny. But fitness is a relative term; for in many cases, as with the Norwegian dwarf birches, the deformed or stunted may be the only ones fitted to survive. An advantage ever so slight must in the long run conquer. The gambler recognizes that final victory must always go with the percentage of the dealer.

The restlessness of individuals is the key to all these problems. Each species of animal or plant is first the product of heredity, and then of the various influences, reactions, and extinctions to which we give the name of natural selection. Each species may be conceived as making every year inroads on territory occupied by other species. If these colonies are able to hold their own in the struggle for possession, they will multiply in the new conditions, and the range of the species becomes widened. If the surroundings are different, new species or varieties may be formed with time; and these new forms may invade the territory

of the parent species. Again, colony after colony of species after species may be destroyed by other species or by uncongenial surroundings.

Only in the most general way can the history of any species be traced; but, could we know it all, it would be as long and as eventful a story as the history of the colonization and settlement of North America by immigrants from Europe. Each region where animals or plants can live has been thousands of times discovered, its colonization a thousand times attempted. In these efforts there is no co-operation. Every individual is for himself, every struggle a struggle of life and death; to each species each member of every other species is an alien and an enemy.

The arctic birches serve as one illustration only of the spread and change of organisms in the face of a barrier apparently insurmountable. I can not enter into detail as to the many ways in which individuals manage to cross the barriers which usually limit the species. These ways are as varied as the creatures themselves, and infinitely more varied than the barriers. It is enough to say that organisms have extended their range in regions where their existence is possible. Here, by the long-continued process of adjustment to circumstances, with the incessant destruction of the unadapted, these organisms have become so well fitted to their surroundings as to give rise to the popular impression that each species now inhabits that part of the world best fitted for its occupation. Yet the very reverse of this must be true, for in the growth of any species it is these features of adaptation which are the last to appear. If, as anatomists now teach, the history of the individual is an epitome of the history of the group to which the individual belongs, then adaptive characters appearing late in the growth of the individual must have appeared late in the history of the group. They are the last changes made in the organism—mere after-thoughts in the work of creation.

For example, the long pectoral fins of the flying-fish enable it to make great leaps through the air, after the manner of the grasshopper. Yet we can not say that the flying-fish was meant to be the bird among fishes, for its nearest relatives are without wings, and the wing-development is one of the last acquisitions of the individual. Its flight is simply an exaggeration of the leaping or skimming which related forms with shorter fins accomplish. The growth of the fins goes on with the increase of this power, and greater power comes with the growth of the fins.

To my mind the strongest arguments for the theory of development are those drawn from the changing character of the species themselves.

No phase in the history of systematic science is more instruct-

ive than the varying attitudes of the naturalist toward those local modifications of species called geographical variations.

It was early noticed that, while individuals of any one species in any limited region are substantially alike, this perfect identity disappears with the examination of wider extent of territory. These differences were often too small to justify the formation or recognition of a new species, but too evident to be wholly neglected. These subordinate species were termed by Linnæus varieties, and their geographical basis was often recognized. Thus, of his *Homo sapiens*, or aboriginal man, Linnæus recognized four varieties—*asiaticus*, *americanus*, *afer*, and *europæus*. As with the varieties of man, so with those of other animals and plants. The individuals of England were not quite those of the same species in Italy, and those in America showed their own peculiarities.

Sometimes these qualities could be exactly measured, in which case a new species was described. Sometimes they proved elusive, and the supposed new species were added to the great dust-heap of synonymy. The work of the systematic zoölogists of the last generation was chiefly in museum cataloguing and labeling. To them these half-tangible varieties were the object of special opprobrium. On the museum shelves they were simply a nuisance, obscuring the characters of the real species and throwing closet-formed ideas of nature into utter confusion. Prof. Cope tells us how variant shells have been crushed under the heel of the indignant conchologist, because they would go neither into species "A" nor species "B." Specimens were often preserved from "typical localities," so that no confusion might be introduced among the cherished specific characters. That Nature went on producing these varying and intermediate forms was no concern of the zoölogist. That such forms were any part of Nature's plan apparently never occurred to the followers of Linnæus.

Says the botanist De Candolle: "They are mistaken who suppose that the greater part of our species are clearly limited, and that the doubtful species are in a feeble minority. This seemed to be true so long as a genus was imperfectly known, and its species were founded on few specimens—that is to say, were provisional only; just as we come to know them better, intermediate forms flow in, and doubts as to the limits of the species become more numerous."

The ease with which slight variations have deceived and confused naturalists is one of the most discouraging features in the history of science. Such variations have formed the basis of thousands of useless and distracting names.

When Darwin was at work upon his monograph of the barnacles, he wrote to a friend:

"Systematic work would be easy were it not for this con-

founded variation, which, however, is pleasant to me as a specialist, though odious as a systematist. . . . How painfully true is your remark that no one has hardly a right to examine the question of species who has not minutely described many! . . . Certainly I have felt it humiliating, discussing and doubting and examining, over and over again, when in my mind the only doubt has been whether the form varied to-day or yesterday. . . . After describing a set of forms as distinct species, tearing up my manuscripts and making them one species, tearing that up and making them separate, and then making them one again (which has happened to me), I have gnashed my teeth, cursed species, and asked what sin I had committed to be so treated."

An epoch in systematic zoölogy began with the study of the collections made by the United States Pacific Railway Survey some thirty years ago. This was the first opening out to naturalists of the details of the fauna of a vast district under the same parallels of latitude, but showing every variation in rainfall, elevation, and physical surroundings. The most valuable results of these collections were seen in the study of birds. It was found in general that each bird of the Atlantic States had its counterpart in the prairies, the sage-plains, the mountains, and the Pacific slope. Differences were carefully sought for and found, for the school of Prof. Baird allowed nothing to escape their analysis. There were differences in size, in form and color, slight in degree, but nevertheless really existing, and these were made the basis of as many distinct species. Still further studies increased the number of these species, until at last a large proportion of our birds were represented by Eastern, Western, sage-brush, and prairie species. Sometimes these closely connected forms were distinguishable at first sight, as in the case of the yellowhammer, and its double, the red-shafted flicker; in other cases baffling the most skillful, as with the two species of the crow-blackbird.

An illustration of these forms and their relations may be taken from the common shore lark and its varieties, although it is fair to say that some of these variations have never been regarded as species.

The shore lark, or horned lark (*Otocoris alpestris*), ranges widely over the colder and open parts of Europe, Asia, and America. The common form, called *alpestris*, is familiar to most of us. In the Northwestern region, as far south as Utah, is another form, equally large, but paler in color (*leucolæma*). In the prairie region the lark is of the ordinary color, but smaller (*praticola*). In the sage-plains, it is a similarly small but pale lark, with brighter yellow in its throat; this is *arenicola*. In Texas the bird is still smaller and grayer (*giraudi*); while the small form found in New Mexico and Arizona has its plumage strongly washed with red;

this is *chrysolæma*. In the interior of California the shore larks are still smaller and redder (variety *rubea*), while northward and coastwise appears a small lark with more streaked plumage; this is *strigata*. All these can be generally recognized by an expert ornithologist, and doubtless a closer analysis would reveal the basis for still finer subdivisions.*

In 1871 Dr. Joel A. Allen published his masterly paper on the Mammals and Winter Birds of Florida. This memoir has had the practical effect of making all our ornithologists, for the most part against their will, believers in the theory of derivation of species.

Dr. Allen took up, as a matter of serious study, the variations in individual birds. He showed that the variation of individuals of the same species was far greater than had been supposed, and that the characters relied on to distinguish species were often due to slight increase in these variations. For example, in Northern birds the bodies would be larger, the bills smaller than in birds of the same species from the South, and the coloration of birds was often directly related to the degree of rainfall. He showed, in brief, that each one of these many variations must be held to define a distinct species, or else that the number of species of American birds would have to be greatly reduced, and the range of variation inside the species would need to be correspondingly extended.

This claim for attention on the part of the despised variety produced much consternation among students of birds. But facts must be recognized; and the final result has been, that we have now extended our idea of each species until it is large enough to include all that we know of intermediate and varying forms. When a hiatus appears, whether existing either in fact or in our material for study, there we put our line of definition. "We can only predicate and define species at all," says Dr. Coues, "from the mere circumstance of missing links. Species are the twigs of a tree separated from the parent stem. We name and arrange them arbitrarily, in default of a means of reconstructing the whole tree in accordance with Nature's ramifications."†

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* In the Auk for April, 1890, is an essay on the Horned Larks of North America, by Jonathan Dwight, Jr. Mr. Dwight's conclusions are based on 2,012 specimens; those of Mr. H. W. Henshaw, above given, on 350. To the forms mentioned above, Mr. Dwight adds *var. aduста*, small, and "scorched pink" in general hue, from southern Arizona and northern Mexico; *var. merilli*, large and dusky, in Idaho and neighboring regions; and *var. pallidus*, very small and pale, from Lower California.

† Dr. Allen says, in a recent paper: "We arbitrarily define a species as a group of individuals standing out distinct and disconnected from any similar group, within which, though occupying different parts of the common habitat, we recognize other forms characteristic of and restricted to particular areas. These reach a maximum degree of differentiation at some point in the habitat, and thence gradually shade into other con-specific forms geo-

What is true of birds is equally the case with other groups of animals. Continued explorations bring to light each year new species of American fishes, but the number of new forms discovered each year is usually less than the number of old supposed species which are found to intergrade with each other, and have so become untenable.

I have myself published three complete lists of the fresh-water fishes of North America. The one published in 1876 enumerated 670 species; that of 1878, 665 species; while the list of 1885 contained 587 species, although upward of 75 new species had been found in the nine years which elapsed between the first and the last of these three lists.

The old idea of a species as a separate entity, a special creation, has passed away forever. We can no more return to it than astronomers can return to the Ptolemaic notion of the solar system. The same lesson comes up from every hand. It is the common experience of all students of species. We have learned it from Gray and Engelmann and Coulter, and from each of the many students of American botany. We have learned it from Baird and Allen and Coues and Ridgway and Stejneger, and from all who have made life-studies of American birds. We have learned it from Cope and Marsh and Leidy, and from all who have searched the rocks for the bones of our ancestors.

I do not know of a single naturalist in the world, who has made a thoughtful study of the relations of species in any group, who entertains the old notion as to their distinct origin. There is not one who could hold this view, and look an animal in the face! The study of the problems of geographical distribution is possible only on the theory of the derivation of species. If we view all animals and plants as the results of special creations in the regions assigned to them, we have, instead of laws, only a jumble of arbitrary and meaningless facts. We have been too fully accustomed to the recognition of law to believe that any facts are arbitrary and meaningless. We know no facts which lie beyond the realm of law. I may close with the language of Asa Gray:

"When we gather into one line the several threads of evidence of this sort to which we have here barely alluded we find that they lead in the same direction with the clews furnished by [other lines of investigation]. Slender indeed each thread may be, but they are manifold, and together they bind us firmly to the doctrine of the derivation of species."

[*Concluded.*]

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graphically contiguous."—On the Recognition of Geographical Forms; The Auk, January, 1890, p. 7.

CENTERS OF IDEATION IN THE BRAIN.*

By BERNARD HOLLANDER.

ON the 22d of February, 1887, Prof. David Ferrier delivered an address in this room on the question, "How far recent investigations on the functional topography of the brain could be brought in relation with craniological and anthropological researches with a view to establish the foundation of a scientific phrenology." It is my object to-night to continue that discussion, and to submit to you the basis of a scientific phrenology for your examination and criticism. I take it for granted:

1. That all mind-manifestation is dependent on brain-matter.

2. That the various elements of the mind have distinct seats in the brain, which, however, have not been as yet determined.

3. That the recent researches by physiological experimenters and pathological investigators—which have resulted in defining distinct regions for motion and sensation—established the physiological correlative of psychological actions.

By applying galvanic currents to definite portions of the brain, or by destroying certain areas, physiological experimenters cause movements of certain limbs and muscles. In itself the distribution of motor areas in the brain would be of little value to the psychologist except that it proves to him the plurality of functions of the brain. When, however, we observe that the movements caused by excitation form the physical parallel of a mental action, we may arrive at the psychological function of a certain portion of brain by reducing the various faculties of the mind to their elements, and watching their physical expression. No galvanic current will ever have the effect of demonstrating a center of ideation—say the center for the emotion of power; on the other hand, there are several emotions and all the higher intellectual operations, which have no outward physical signs. All which the excitation of that portion of brain where the emotion of power may have its center can effect is certain movements which such an emotion would cause when irritated.

To arrive, then, at the demonstration of centers of ideation there is but one way:

1. We must observe the physical expression of our thoughts and feelings, as far as possible; in other words, we must study the outward visible signs of their manifestation.

2. We must take the limbs and muscles, which are affected by definite emotions, and see on what occasions they are made to move by central excitation.

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* A paper read before the Anthropological Institute, London, February 12, 1889.

Let me give an example. The outward sign of a joyful emotion is a drawing up of the corners of the mouth. The elevation of the angles of the mouth is the muscular action going parallel with the emotion of joy. The excitation of the nerve-center causes the elevators to act. There is but one definite area from which the elevator muscles can be made to act, therefore joyful emotions must take their start from this center. When, then, a joyful emotion excites this definite portion of gray matter, a nerve-current passes to the lower center—the center for the movements of the elevator muscles—and causes them to act. As the brain is a very complex machine, other effects may be produced at the same time, but this one has always been associated particularly with exhilarating emotions. Persons of very cheerful dispositions make the elevators act so frequently that the mechanism of the nerve-display is facilitated by constant use, and the center will easier appreciate these special impressions. The elevators will be in time so accustomed to act that they will leave impressions on the face so marked to enable people to recognize, by mere physiognomical signs, their brethren who are of such disposition.

Now, let us see what the actual experiments were.

Prof. Ferrier applied a galvanic current to the ascending frontal convolution in monkeys on a definite portion, marked 7 (Fig. 1), and to the corresponding region in dogs, jackals, and cats, all with the effect of elevating the cheeks and angles of the mouth with closure of the eyes. On no other region could the same be effected.

FIG. 1.—DIAGRAM. (David Ferrier.)

(7) Center for the movements of the elevator muscles.
(15) Gustatory center.
(11) Center for movements of the "platysma myoides muscle."
(5) Center for movements of the arm and raising of the shoulder. (Patience muscles.)

Darwin (Expression of the Emotions, p. 202, etc.), says: "Dr. Duchenne repeatedly insists that under the emotion of joy the mouth is acted on exclusively by the great zygomatic muscles, which serve to draw the corners backward and upward. The upper and lower orbicular muscles are at the same time more or less contracted. A man in high spirits, though he may not actually smile, commonly exhibits some tendency to the retraction of the corners of his mouth. According to Sir Charles Bell, in all the exhilarating emotions the eyebrows, eyelids, the nostrils, and the angles of the mouth are raised. The tendency in the zygomatic

muscles to contract under pleasurable emotions is shown by a curious fact communicated to me by Dr. Browne with respect to patients suffering from general paralysis of the insane: 'In this malady there is almost invariably optimism — delusions as to wealth, rank, grandeur—insane joyousness, benevolence, and profusion, while its very earliest physical symptom is trembling at the corners of the mouth and at the outer corners of the eyes. This is a well-recognized fact.'"

We have, then, sufficient evidence that the effect produced by a galvanic current on the portion of brain marked 7 in Ferrier's

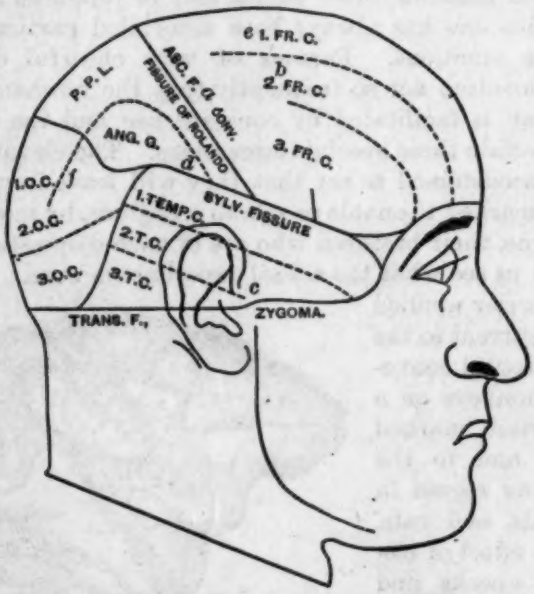

FIG. 2.—DIAGRAM OF CRANIO-CEREBRAL RELATIONS. (Reid.)

Some of the results of observations made by the early phrenologists:

a, *Hope:* the organ of cheerfulness.
b, *Imitation:* the organ of mimicry.
c, *Alimentiveness:* the gustatory organ.
d, *Cautiousness:* the organ of circumspection, fear, timidity.
e, *Veneration:* the organ of submission, respect, devotion.
f, *Attachment:* the organ of friendship.

Some of the results of experiments made by modern physiologists:

a, Center for the movements of the *elevator muscles* (elevating the cheeks and angles of the mouth).
b, *Facial Nerve Center:* center for facial movements.
c, *Gustatory Center.*
d, Center for movements of the *platysma myoides*, the muscle of fright.
e, Center for movements of the arm and raising of the shoulders. *Patience Muscles.*

topography is the physical expression of joy. We know, then, for positive that pleasurable emotions excite this center. But I do not say that it is the function of the center to produce an emotion of joy—a manner after which the old phrenologists would have expressed themselves—I merely note that all pleasurable emotions produce a nerve-current, which takes its start in this region.

Sir Crichton-Browne tells us that, in general paralysis of the insane, there is invariably optimism, beginning generally with trembling at the corners of the mouth and the outer corners of the eye. The old phrenologists located "hope" in this region (*a*, Fig. 2), and there is, no doubt, a strong relation between hope and optimism; and I find, in the writings of Combe, frequent allusions that this organ gave a tendency to cheerfulness. At the same time I must note that Gall, the founder of phrenology, did not admit "hope" as a faculty, but included this portion of brain in his organ of "imitation," or "center for mimicry," of which I shall speak directly.

There are many defects in the old phrenological system; one of them being that it rather favored complex functions. But, all the same, an unprejudiced investigator must take their observations into consideration. I need not remark that, when I refer to phrenology, I mean only the observations of Gall, and not the fancies and fallacies of his followers.

This center for the elevator muscles, and probable center from which exhilarating emotions take their start, is in close connection with Exner's center for the facial nerve.

Ferrier's center, No. 7, is a little lower than the center for the "nervus facialis" as located by Exner (Localisation der Functionen in der Grosshirnrinde des Menschen, Wien, 1881). The "nervus facialis" center occupies a very large portion of brain in Exner's collection of pathological evidence. The most intense centers for facial movements are localized by him in the squares marked 57, 58, 65 (Fig. 3), but are said to extend actually from the gyrus centralis anterior to the latter halves of the lower frontal convolutions. He quotes many cases of disease of this nerve, and is particularly struck with the frequency with which disease of the facial nerve and aphasia concur. He says (page 56) it can not be mere chance that paralysis of the facialis is frequently accompanied by aphasia and the reverse—an observation which was also made by Ferrier.

There is sufficient evidence that the center for the facial movements occupies an area extending from the ascending frontal convolution to the middle frontal convolution—a fact which was noted by Gall. He located in this region the talent for mimicry, the talent of imitating the gestures of other people (*b*, Fig. 2); more than this, he noted that, when this region was prominently developed, there was not only a talent for mimicry, but also a talent for the imitation of the voice of other people, and many examinations and casts of heads of eminent actors were made to prove this theory.

We have heard from Exner and Ferrier how closely the speech and facial nerve centers are connected; both in perfection

being necessary for a clever actor. But let me quote Gall himself. Speaking of a man with a peculiar prominence of this region, he says:

"He imitated in so striking a manner the gait, the gestures, the sound of the voice, etc., that the person was immediately recognized. I hastened to the institution for the deaf and dumb to examine the head of the pupil Casteigner, who had been received into the establishment six weeks previous, and who, from the first, had fixed our attention by his prodigious talent for imita-

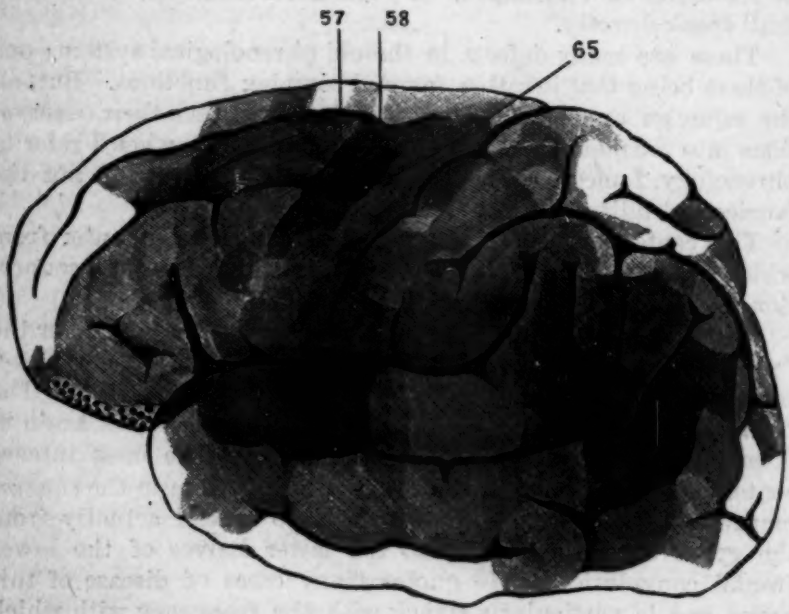

FIG. 3.—DIAGRAM. (Sigmund Exner.) The darkest squares are Nos. 57, 58, 65, and are the most intense centers for the movements of the facial muscles.

tion. On Shrove-Tuesday, when a little theatrical piece is usually represented in the establishment, he had imitated so perfectly the gesture, the gait, etc., of the directors, inspector, physician, and surgeon of the institute, and especially of some women, that it was impossible to mistake; a scene which amused the more, as nothing like it was expected from a boy whose education had been absolutely neglected."

He goes on to explain that many men have a natural talent for the stage or pantomime, and that the history of the lives of great actors shows that the majority of them had received little education and were intended for some other profession, but their innate disposition drove them to the stage. The faculty of imitation is exercised sometimes even in idiots and madmen. Pinel says:

"A young idiot, whom I have long had under my eye, has the most marked and irresistible inclination to imitate all that she sees done in her presence; she repeats mechanically all that she hears said, and imitates with the greatest fidelity the gestures and actions of others, without much regard to propriety."

I can not go into details to-night as to the ample evidence, pathological and otherwise, which the early phrenologists brought forward in their time. They were only ridiculed and treated as charlatans. To-day people know nothing of the old phrenology, except what they hear from opponents and read in books by some phrenological dilettanti. Scientific men think Gall's theory exploded, because Sir William Hamilton and Flourens appeared to disprove it; but we know, since 1870, that the doctrines of these two men are equally valueless, for Flourens taught that the whole brain acted as an organ of the mind, and not, as we know now, that special parts of the brain have separate functions; while Sir William Hamilton considered it impossible to form a system on the supposed parallelism of brain and mind. L. Landois (Lehrbuch der Physiologie) recommends a re-examination of Gall's theories, and I hope to show you to-night that, whatever you may think of the phrenological system, Gall's fundamental observations were correct.

Ferrier's experiments on monkeys on the anterior and inner aspect of the uncinate gyrus, marked 15 (Fig. 1), had the effect of "torsion of the lip and semiclosure of the nostril on the same side, as when the interior of the nostril is irritated by some pungent odor." He says (page 244, The Functions of the Brain, London, 1886):

"Irritation of the middle temporo-sphenoidal convolution I have found in general to be without any obvious reaction except toward the lower extremity, where in several instances movements of the tongue, cheek-pouches, and jaws were induced very much like those which are characteristic of tasting."

The same experiment on 15, the uncinate gyrus or extremity of the temporal lobe of dogs, had the result of "torsion of the nostril on the same side, as if from irritation directly applied to the nostril." The same effect was produced by experiments on cats and other animals. He continues:

Page 315: "As above described, irritation of the hippocampal lobule in the monkey, cat, dog, and rabbit was attended by essentially the same reaction in all, viz., a peculiar torsion of the lip and nostril on the same side. This reaction is precisely the same as is induced in these animals by the direct application of some strong or disagreeable odor to the nostril, and is evidently the outward or associated expression of excited olfactory sensation."

Page 321: "As to the sense of taste, I have not succeeded in

differentiating any special region related to this faculty, but that it is in close relation with the olfactory center is probable from the facts described. It was noted in connection with electrical irritation of the lower extremity of the temporo-sphenoidal convolutions in the monkey, and of the same region in the brain of the cat, that movements of the lips, tongue, cheek-pouches, and jaws were occasionally induced—phenomena which might be regarded as indications of the excitation of gustatory sensation. This interpretation receives support from the above-described results of destructive lesions; and we have, therefore, reasonable grounds for concluding that the gustatory centers are situated at the lower extremity of the temporo-sphenoidal lobes, in close relation with those of smell."

Page 431: "The physiological needs of the organism, in so far as they induce locally discriminable sensations, express themselves subjectively as definite appetites or desires, which are the conscious correlations of physiological wants. The appetite of hunger is the desire to satisfy or remove a local sensation, referable to the stomach, in which the physiological needs of the stomach express themselves. The substrata of the feeling of hunger and appetite for food are the stomachic branches of the vagus and their cerebral centers; and, as local conditions of the stomach may destroy or increase the feeling of hunger, so central disease may give rise to ravenous appetite or sitophobia, conditions exemplified in certain forms of insanity."

Ferrier thus proves the tip of the lower temporal convolutions to be the "gustatory center"; and even Hitzig, who is not always flattering to Prof. Ferrier, delights in noting this discovery. Yet I will show you immediately that this center—of which we are most certain—was known and correctly localized in the same portion of brain by the early phrenologists.

Many men claimed the discovery of the organ called "gustativeness," or "alimentiveness," but the editors of the Edinburgh Phrenological Journal, vol. x, page 249, give Dr. Hoppe, of Copenhagen, the credit of having been the first and most acute observer.

"In December, 1823, he expresses the opinion that, besides the nerves of the stomach and palate, of which alone he conceives the sensations of hunger and thirst to be affections, there must be also an organ in the brain of animals for the instinct of nutrition for the preservation of life, which incites us to the sensual enjoyments of the palate, and the activity of which is independent of hunger and thirst."

In a second communication to the same journal, dated 28th December, 1824, he says:

"Regarding the organ for taking nourishment, I have been led

to think, since I wrote last, that the place where its different degrees of development are manifested in the living body is in the fossa zygomatica (*c*, Fig. 2). Before I had thought at all of phrenology I was struck with the remarkable breadth of the face or head of a friend of mine, caused, not by prominent cheekbones, as in some varieties of mankind, but more toward the ears, by the great convexity of the zygomatic arch. Knowing that this individual was exceedingly fond of good living, and that, even in spite of a very powerful intellect, and propensities moderate in almost every other respect, he was prone to indulge too freely in the joys of the table, I afterward thought that this form of the head and tendency of the mind might bear a nearer relation to each other than had at first occurred to me; and in some other persons, notoriously fond of good eating and drinking, I found a confirmation of my suppositions. This prominence of the bony arch, I think, must be an absolute consequence of the part of the cranium lying under the temporal muscle being pushed outward, and diminishing in that direction the space of the fossa."

Dr. Hoppe considered the organ "alimentiveness" to be likewise the organ of taste. He says:

"That the sensation of taste only passes through the nerves and is perceived in a part of the brain is a supposition, I think, sufficiently proved. Now, it appears to me as highly probable, and by analogy agreeing with other experience, that it is one and the same organ which tastes, viz., distinguishes and enjoys, and incites us to taste, or, in other terms, to take food and drink. This, according to my opinion, is the organ of appetite for food, and consequently it may be named the organ of taste, gustus."

Dr. Crook, of London, mentions that, several years before the publication of Dr. Hoppe's papers, he himself had arrived at similar conclusions with regard to this faculty and the position of its organ. He says:

"Three persons with whom I had become acquainted in the year 1819, first led me to suspect that a portion of brain situated near the front of the ear was connected with the pleasures of the festive board. From that time to the end of 1822 above a thousand observations were made. As they tended to confirm this view, several phrenological friends were informed of the result. From 1823 I no longer doubted that the anterior portion of the middle lobe was a distinct organ, and that its primary use was the discrimination and enjoyment of meats and drink. It was difficult, however, to hit the fundamental power. The situation of the organ, under the zygomatic process and the temporal muscle, frequently precluded the possibility of accurate observation. But, notwithstanding, well-marked cases, both of a positive and a negative kind, were investigated."

A long controversy follows this paper on "alimentiveness," the gustatory center, in the Phrenological Journal, and much ridicule was thrown at the originators for localizing a center for hunger and thirst, those affections being thought due to the stomach alone. Even to-day scientific men say phrenology is exploded, because certain thicknesses in the skull and the various muscles make it impossible to distinguish the corresponding portions of brain; yet it is remarkable that the organ which has been ridiculed most, and which was the most difficult to observe, is to-day found correct.

If there were but two organs correctly localized by Gall, it would justify a reconsideration of his work; but there seems to be a number of faculties, the localization of which has been confirmed by modern experiments. Unfortunately, the later phrenologists have spoiled many of Gall's original observations. I will just give a few more examples, in order that my paper may receive sufficient consideration, and may effect a change in your views with regard to the old phrenology.

Prof. Ferrier's experiments on "the lower extremity of the ascending parietal convolution" in monkeys, marked 11 (Fig. 1), resulted in "retraction of the angle of the mouth. The action is that of the platysma myoides."

Darwin (Expression of Emotions, page 298) says with regard to the physical expression of "fear," and the platysma myoides muscle:

"Sir Charles Bell (Anatomy of Expression, page 168) and others have stated that this muscle is strongly contracted under the influence of fear; and Duchenne insists so strongly on its importance in the expression of this emotion that he calls it the muscle of fright."

This may perhaps suffice to show that the platysma myoides muscle is called into action in the expression of fear.

Now let me draw your attention again to the old phrenology. Gall located so-called "cautiousness" in an area which covers not only Ferrier's center 11, but also the angular gyrus (*d*, Fig. 2). He found an enormous development of this region in persons known for their timidity, persons known to take alarm easily, and who could be easily terrified.

As to the function of the angular gyrus, physiologists are not agreed. Ferrier includes the gyrus in his center of sight. Munk calls it "Seelenblindheit"—a strange name with a still stranger meaning.

I will quote some passages which seem to indicate that the effects produced by lesion of this region have some connection with the function attributed to it by phrenologists.

Ferrier, Philosophical Transactions, 1875, Part II, pages 445–451,

Résumé: "After destruction of the angular gyrus the animal commences to feel about cautiously; if pushed to move, it runs against every obstacle on its way. If put on the floor, it cries out and looks about quite frightened. If called, it points its ears and cries. If taken up again, it clings to one as if afraid of being put down. On the other hand, threatening with the stick has no effect unless the stick is brought in contact with the eyes."

Munk (Functionen der Grosshirnrinde, page 25 etc.) makes the same observations as Ferrier, only his region of destruction, marked A_1 (Fig. 4), includes a portion of brain where Gall located his organ of "friendship" or "attachment" (*f*, Fig. 2); and Munk, speaking of the effect, says: "However, the animal remains cold at the sight of men, whom it used to greet most friendly, and even at the sight of dogs, with whom it used to play"; an effect which can be easily explained on phrenological principles by the loss of the organ of "attachment" or "friendship." He goes on to remark that the whip, which formerly frightened the animal away to a corner, has now no effect. The animal stops before every obstacle on its path and turns back again; one has to push it to go up any steps, and then it feels its way with its nose, though not blind. When recovering, it stares at everything and examines every object most cautiously, both when lying down and walking about, just as if it had to learn afresh and gain new experience.

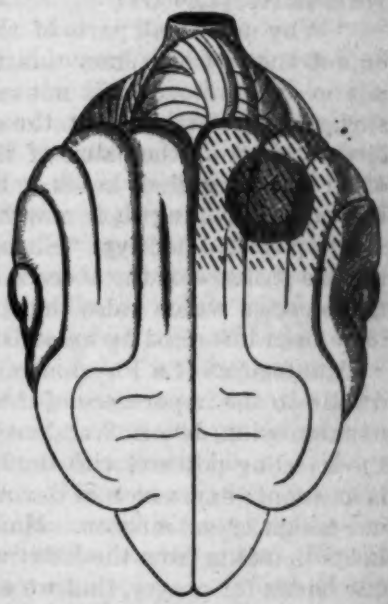

FIG. 4.—DIAGRAM. (Hermann Munk.) Extirpation of area marked A_1 causing loss of social attachment, and of the emotion of fear.

Goltz (Verrichtungen des Grosshirns, page 18, etc.) says it is a well-known fact that animals are easily put into rage by the appearance of a person in strange costume. He got his servant dressed up in fantastic attire, and his dog would have torn him to pieces had not proper precautions been taken. When the dog, however, had been operated upon, and the experiment was repeated, he remained perfectly calm, even when the servant stepped quite close to him, though the animal was by no means blind.

It is not difficult to detect in all these experiments an affection of some faculty which, when excited, causes timidity. What the

element of that faculty is I can not tell, but in its actions it is concerned with the emotion of fear.

Prof. Ferrier found, when experimenting on dogs and other animals on a portion of brain marked 5 (Fig. 1), which corresponds to "the ascending frontal convolution at the base of the superior frontal" in the human brain, elevation of shoulder and extension forward of the opposite fore-limb, or flexion of the fore-arm and paw.

Now, according to Darwin, raising of the shoulders—sometimes accompanied by extension of the arms—is a sign of non-resistance. He inquires, page 271:

"Why men in all parts of the world when they feel—whether or not they wish to show this feeling—that they can not or will not do something, or will not resist something if done by another, shrug their shoulders, at the same time often bending in their elbows, showing the palms of their hands with extended fingers, often throwing their heads a little on one side, raising their eyebrows, and opening their mouths."

On page 270 he says: "Shrugging the shoulders likewise expresses patience or the absence of any intention to resist. Hence the muscles which raise the shoulders are sometimes called, as I have been informed by an artist, the patience muscles."

Mantegazza (La Physionomie et les Sentiments, page 113, etc.) dwells on the importance of the movements of the arm in the act of submission, devotion, and veneration. Darwin doubted whether the kneeling posture, with the hands upturned and palms joined, is an innate expression of devotion, but rather thought this posture a sign of submission. Mantegazza differs from Darwin; he holds that it is from the habit we have from our childhood to join our hands for prayer, that we employ the gesture when appealing to human beings, who can do us either much good or great harm. He thinks this gesture is innate and not acquired. He questioned many artists, and gives as the result distinct rules, showing the importance which the position of hand and arm play in the expression of veneration and devotion.

We know, then, that the raising of the shoulders, together with the bending of the arms and hands, are concerned in the physical expression of submission or non-resistance.

The old phrenologists located in this region their organ of "veneration" (*e*, Fig. 2) which is to give an impulse to devotion and worship. Combe (System of Phrenology, page 212) says: "Children who are prone to rebellion, regardless of authority, and little attentive to command, will generally be found to have this organ deficient. Veneration leads to deference for superiors in rank as well as in years, and prompts to the reverence of authority."

Large "veneration," say the phrenologists, produces an instinctive feeling of respect; a defect of "veneration" has the effect of diminishing the reverence for power. Dr. Spurzheim called it the emotion of reverence and respect.

We see again the strong relation between the old phrenology and the results of the experiments of modern phrenology. On the one hand, I have shown you that the effect produced by Ferrier's faradization is the natural language of a feeling of non-resistance; on the other, that observations of Gall resulted in ascribing to this portion of brain the seat of the emotion of respect and reverence. Of course, respectful people do not resist authority.

Gall appears to me to have been aware of the importance that the study of the physical expression of our emotions and thoughts will play some day, and to have been expecting that this study of the physical parallel to our mental operations will furnish new evidence for his or any other system, built upon the parallelism of brain and mind. He devotes a chapter to pathognomy, of which the following extract may prove interesting: "This art is founded on Nature herself; for it is Nature that prompts all the gestures, the attitudes, the movements, finally the whole mimicry, by which men and animals express all their feelings and ideas. Pathognomy has its fixed and immutable laws, whether we appy it to man or to animals, so long as the question relates to the same feelings and the same ideas. Pathognomy is the universal language of all nations and of all animals. There is no beast or man who does not learn it; there is no beast or man who does not understand it. It accompanies language and strengthens its expressions; it supplies the defects of articulate language. Words may be ambiguous, but pathognomy never is so. What would become of engraving, painting, sculpture, the comic art, eloquence, poetry, if the expression of the sentiments and ideas were not subjected to immutable laws? What means would they have in their power to paint modesty, prudence, fear, despair, baseness, joy, anger, contempt, pride or devotion? Where is the animal or man who takes time to deliberate on the manner in which he would make his feelings and his ideas understood by others? Even at the moment when the feelings and the ideas arise, they are written on the exterior in characters discernible by all the world. It is certain, therefore, that the feelings, ideas, affections, and passions are manifested by suitable expression according to determinate and invariable laws."

Gall noted the physical expression of our emotions, though he could give us no explanation of its cause.

With the assistance of Hitzig, Fritsch, and Ferrier's experiments on the one hand, and Gratiolet, Piderit, Darwin, and Man-

tegazza's observations on the other, I have endeavored to show you to night: (1) the reason why certain muscles and limbs are called into action by certain feelings and emotions; and (2) how to demonstrate centers of ideation by comparing the physiological experiments with pathognomy.

My work is, however, not complete: for, first of all, I have not attempted to find the elements of those faculties which I located; secondly, we must take into consideration that mind, like brain, is very complicated, and, even had philosophers ever agreed as to its elements, we know from experience that an emotion seldom acts singly.

Like all novelties, my paper will create some opposition, but I do not fear criticism: I only ask for a re-examination of Gall's work, which I believe has been rejected without due consideration.

DISCUSSION.

Dr. Beddoe thought that, although phrenologists had erected an edifice of straw and rubbish on the foundations laid by Gall and Spurzheim, these last had been men of considerable power and acuteness, whose observations ought not to be neglected in any new attempts at the localization of faculty.

Dr. Ferrier remarked that, as the relations between brain and mind were still in many respects very obscure, he cordially welcomed any attempt to throw light on the problem. So far the physiological or objective functions of certain cerebral regions had been determined, but the question was, What are the correlations between the objective and the subjective or psychological aspects of these same regions? As the brain was composed of sensory and motor substrata, and as the brain was the organ of ideation, therefore ideation was the functioning of centers whose objective functions were motor and sensory. That there was a relation between the development of certain regions and certain motor and sensory faculties and capacities was undoubted, and was amply proved by the facts of comparative anatomy and physiology, normal and morbid; but whether any particular center could be taken as the index of any particular intellectual faculty or peculiarity was a totally different matter, for the same center might be called into activity in connection with unnamable mental states. Of which, then, would it be the index? Mr. Hollander's speculations in reference to so-called phrenological doctrines were ingenious; but what we wanted was evidence founded on careful investigation according to strictly scientific methods, serving to indicate a relation between the development of particular centers and special mental faculties, aptitudes, or peculiarities. At present he did not think that there was any such worthy of consideration, beyond the general indications above mentioned.

But the subject was one which was worthy of careful study, and a scientific phrenology might one day become possible.

Mr. Wakefield said that, as men's minds undoubtedly differed from each other in their natural characteristics, so, it might be presumed, did also the physical organs through which mind manifested itself. Was it possible to detect these differences? Were there, also, localized centers of action corresponding to certain faculties or powers of the mind? This was the problem for solution and demonstration. Some facts had come under his observation which led him to think that the solution was not hopeless; but the advance made in this department of knowledge as to the true relation of mind and body was but slow and uncertain.

Mr. G. Bertin remarked that it had been ascertained that the faculty of sight was localized in a convolution of the posterior part of the brain, and as we know that the faculty of speech is localized in the third left frontal convolution, it would seem that modern discoveries disprove the assumptions of the phrenologists. One great mistake of their system is to attribute the same faculties to the two lobes of the brain, a fact disproved by the localization of the faculty of speech on the left side. Another thing lost sight of is, that the examination of the head could only show the development of the surface of the brain, while we have no means to detect its inner development. Nor must we forget that the skull does not change after a certain age, though faculties may be still developing. Another mistake of phrenologists is to localize faculties too much; if phrenology is to become a science, broader lines will have to be followed, and Mr. Hollander's careful researches will do much to further this object.

Mr. Hollander, in reply, observed that nobody disputes the fact that there are brain-centers for ideation; the question is only as to their localization. But as the objective side—i. e., the physical correlative of mental manifestation—has been in many cases successfully established, there remains but the demonstration of the subjective side. How far the speaker had succeeded in this may be judged when the paper is read in type. So far he had not excited opposition. But now comes the coincidence that some of Prof. Ferrier's researches, especially on the gustatory center, confirm the early phrenological observations long ago rejected. By careful examination and a thorough study of Gall's works the speaker found that there was a sound basis to his system. Gall had extraordinary powers of observation, and was an expert in comparative anatomy. He noticed the resemblance between the skulls of murderers and the skulls of carnivorous animals; the predominance of the temporal lobe struck him, and both Prof. Benedict and Lombroso—the authorities on criminal anthropology—testify as to its correctness. Gall, in the same manner, noticed

peculiarities in the heads of actors, poets, musicians, etc. He reasoned that there must be in the case of murderers an organ giving an impulse to destroy or kill ("destructiveness"), in the case of mimics an organ giving an impulse to imitate ("organ of imitation"), etc. Now, these deductions are open to criticism, but the original observations are beyond dispute. There are no two characters alike, neither are there two skulls alike. The question in both cases is, how to measure the differences. There is no instrument for the measurement of those "ups and downs," protuberances and depressions of the living head. Between the skull of a Goethe and that of a murderer there are innumerable varieties. As we are able to distinguish the two extremes, why should we not succeed in demonstrating the intermediate stages? Gall's system was rejected at its first appearance, because it threatened to upset familiar notions about the liberty of the will, about special creation, and supernatural religion. This was the first obstacle, and very few men, even nowadays, care to risk the danger of opposing popular opinion. The author had attempted a revival of Gall's system, more scientific and appealing to the learned only. He hoped that it would be received without prejudice.

A QUEER PET.

By ELIZABETH W. BELLAMY.

ONCE, for ten summer days, I had the pleasure of entertaining a strange and most interesting guest, known among the learned as the *Mantis religiosa;* but the more familiar appellation of devil's-riding-horse, by which he is designated amid his native haunts, seems so appropriate to his demoniacal oddity that the creature might be recognized thereby on sight, without description. He looks much more like a nag for an imp of the Inferno than like a locust at prayer, despite the attitude as of supplication assumed when about to snap up an unwary fly.

I captured my specimen upon the stalk of a common geranium, to the pale-green color of which the hue of his long, slim, grotesque body so closely approximated that it was by the merest chance I espied him. Owing to this accommodation of tint—in summer, like the grass and plants amid which he seeks his prey, and, in autumn, like the twigs and branches whereon he alights—the praying mantis, though by no means a rarity in the fields and gardens of the South, commonly escapes all eyes save the sharpest. My prize was stalking his prey when I espied him. Nothing can be stiller than the *Mantis religiosa* when he is waiting to spring upon his victim; and at that propitious moment, armed

with a tumbler in one hand and a palmetto fan in the other, I made him my captive. I might have taken him with my fingers easily; but, though I do not believe, as the negroes do, that the bite of the devil's-riding-horse is "bad luck," or that this insect will "curse with blindness" by spitting in its captor's eyes if it can, I have a horror of the creature, and I prefer not to touch it.

FIG. 1.—MANTIS RELIGIOSA.

By way of introduction to those who do not know the *Mantis religiosa*, I would explain that he is classed with the *Orthoptera*, whereby is declared his kinship with the crickets, locusts, roaches, and grasshoppers; yet he is not cheery like the cricket, nor destructive like the locust, nor loathsome like the roach, nor vivacious like the

"Gay little vaulter in the sunny grass."

Nor does he resemble any one of these in personal appearance. Entomologically he is described in an array of big words which say but little for the particular specimen that amused my midsummer idleness. It is not as an entymologist, therefore, that I would portray my queer pet.

To the non-entomological intelligence, then, my captive appeared a pale, yellow-green, miniature *demon*, about two inches in length, the most of whose body, so to speak, had run to neck. About midway of this "neck"—or *pro-thorax*, to quote the entomologists—were attached a pair of "arms"—*antennæ*—with joints like "elbows." Below these joints the arms were divided and serrated, like the claws of a crab. Atop of the long neck the head was set transversely, like the upper portion of the letter T. An extremely flexible joint united this peculiar head to the rigid neck, and enabled the creature to look in all directions, out of a pair of extraordinarily intelligent and watchful eyes, that protruded from each "end" of the head. The mouth was very large, but, in spite of the powerful jaws, there was no expression of ferocity in that rather formidable feature. In normal condition the body proper, which is perceptibly shorter than the neck—so called—should be furnished with four slender, jointed legs, about an inch in extended length; but when under glass my prisoner was seen to be minus the right hind-leg. This deficiency, however, did not appear to interfere in the least with his activity, for he scrambled about his glass cell with a frantic speed that proved five legs as good as six in his case; of course, the two raptorial "arms" count as legs when it comes to locomotion.

By way of beginning my study of his character, I dangled a shoe-button first on one side and then on the other of his prison-

house, sometimes at the top and sometimes at the bottom of the glass; and it was then that I discovered the wonder of the tiny creature's eyes, the alertness of his intelligence, the extraordinary flexibility of the minute joint upon which the head is made to turn. He was not at all alarmed by the dangling black button, which he evidently mistook for a particularly choice dinner; but he was plainly puzzled, and finally distressed, by his inability to attain possession of this alluring dainty, seemingly within his very grasp.

So long as the button was in his sight, his whole being was absorbed in the effort to possess it; but, that object removed from his vision, he made the surface of the glass his study, feeling it with his thread-like tongue, and stretching out his anterior, raptorial feet, with an evident air of inquiry, along the transparent walls that shut him in so incomprehensibly.

Of course, the captive could not long remain in such a prison, and at this juncture a small boy came to the rescue. When the devil's-riding-horse is a subject of study, the small boy is an invaluable coadjutor; he quickly becomes expert as a purveyor of delicacies in the shape of living insects, for dead ones the dainty mantis will not deign to accept. The small boy, in this instance, perceiving at once the value of my captive, and the inadequacy of his lodging, forthwith provided a discarded fly-trap of wire gauze, cylindrical in form, six inches in diameter, and about nine inches in height, surmounted by a top of tin. The lack of a fixed flooring was supplied by a bit of cardboard.

The devil's-riding-horse was manifestly pleased with his transference to his more spacious abode, and he looked about him with a very comical air of studious observation. The wire gauze offered no more obstacle to his locomotion than did the glass, but he was plainly puzzled over the difference between the walls of this prison-house and those of the one he had left: for a little while he seemed to be weighing the problem intently, putting out a cautious claw for inquiry, and turning his head with an expression of deep attention from side to side, and pausing every now and then, in his upward course, to examine this strange new surface.

The first meal we offered our fantastic guest was a dead fly, but this he disdained in any way to notice; though he was repeatedly shaken to the bottom of the cage where the dead fly lay, he refused even to see it. Thereafter our fastidious captive had his meals served to him *au naturel*. The living fly was simply turned loose in the cage, and instantly the devil's-riding-horse was on the alert: warily he crept up the sides of the cage, settled himself in a position to spring, and then the fly would move, and the slow, laborious work of creeping upon his prey had all to be

done over again. But the patience of the devil's-riding-horse in pursuit of a dinner is inexhaustible, his perseverance indefatigable, and sooner or later the fly was inevitably his: with a snap like a steel trap, he clasped his victim, and, settling upon his haunches, he stripped off the gauzy wings—but at this point I fled. The small boy, however, had a stouter heart, and presently he announced that the meal was over; the devil's-riding-horse had devoured the fly, every atom, and was *licking his claws!*

We had a good magnifying glass wherewith to pursue our study of the prisoner, but it was easy enough to discern all his movements, his very expression, with the naked eye. Every one has seen flies go through the performance children call "washing its face," a sight so familiar that we fail to be impressed by it. In the devil's-riding-horse this is a most amusing exhibition. Our specimen would thrust out his filament of a tongue, carefully lick his serrated claws, examine them closely, scratch the back of his head which he twisted from side to side, rub one jaw and then the other, and turn and look at us out of those strange eyes of his, as if to rebuke our impertinent staring. Not infrequently he would end the performance with a mighty yawn—inaudible, of course—and scamper away, as far as his limits would allow. His bearing altogether was calculated to impress one with the idea that he entertained a serene contempt for the whole human family.

Fig. 2.—Mantis religiosa, with head raised.

Apparently he did not object to his imprisonment, for he showed no disposition to escape when, time and again, the opportunity was offered him; and except when a fly was introduced to his consideration, he usually remained motionless against the side of his cage, as often as not with his head downward. He never, of his own accord, betook himself to the bottom, not even in pursuit of his prey, and he finally came to prefer the tin top of the cage—possibly on account of the shade it afforded—clinging there like a fly to the ceiling. If we inverted the cage, he instantly crawled upward and clung to the bit of cardboard that did duty for a top. Once, when one of his claws was accidentally caught

between the cardboard and the tin rim of his cage, he dropped down and stood shaking the wounded member, just as a boy shakes his hand when he has caught his finger in a door; then he licked his bruises, holding up the tiny claw and carefully examining it.

Early on the morning of the seventh day after his capture, his friend the small boy announced that the devil's-riding-horse had shed his skin, and had grown to twice his former size! But this was not strictly accurate. The mantis had indeed shed his skin, which lay in the bottom of his cage like a shrunken and discarded garment, or rather like a sort of abandoned self, so perfect was every feature of the outgrown mask; but the devil's-riding-horse, though wonderfully expanded in his new estate, was not *twice* as large as we had known him the day before. In other respects, also, he showed a difference: he was beginning to change color; a small brown spot was visible on the back of his folded wings, and in two days more he was as brown as his cage—as brown as any twig he might elect, in his coming freedom, to alight upon. But, strangest change of all, *the missing right hind-leg was there*, very much shorter than its fellow; and, whereas our devil's-riding-horse had never heretofore seemed to be conscious of his deficiency, he now went lame! However, for yet another marvel, in a few days more, that tardy leg was as well developed as the others.

About this time we discovered that something ailed our prisoner. He clung more persistently than ever to the top of his cage, and could hardly be induced to stir, even for a fly. Still, he would at his leisure make a dash at every insect offered him; but, though he captured and killed his prey, he did not devour it. Therefore, lest he should die on our hands, we decided to release him. For this purpose we took him to the same flower-stand where he had been captured, and on a bare shelf, exposed to the blazing noon, we reversed the fly-trap, leaving it open to the sky. The captive was, as usual, clinging to the tin top of his prison-house, but, the instant he perceived himself at the abhorred bottom, he began to crawl up the side of the cage.

Now, we had expected that the release of this prisoner would be a very tame affair of ready wings; but there was a dramatic surprise in store for us. When we looked to see our mantis "spread his sheeny vans for flight," he paused on the tin rim that bound the wire gauze, and lifting that queer head of his until it almost lay back on his neck, he gazed up at the sky; turning slowly from side to side, he took a long survey of the heavens, his vision in no way troubled, it would seem, by the blinding light. After several seconds of this sky-gazing, he shifted his position slightly, and peered down at the depth from which he had ascended; then he looked at the sky again, and again he peered at

the bottom of his cage. Evidently he was puzzled; heretofore, when he climbed those walls, he had invariably found a rest at top—tin at one end and cardboard at the other; but this vast expanse of light was a marvel to be pondered and not too rashly accepted. That mantis never did fly; he crawled around the edge of the cage at last to a spot where it touched a higher shelf of the flower-stand, and, as if he had just discovered that he was a prisoner no longer, scrambled with more haste than discretion up to the next shelf, where a huge black spider, whose lair was just under the verge of the shelf, pounced upon him so suddenly that retreat was impossible. The mantis was taken completely by surprise, and the start he gave was so violent that but for the spider's swift, encompassing arms, he must have fallen backward off the shelf. Thereupon ensued a terrific struggle; the devil's-riding-horse made a brave resistance, but the spider would have proved too much for him, so his late jailer, armed with a broom-straw, separated the combatants. The spider retired to the shadow of the shelf, and the mantis, climbing upon the leaves of a mespilus-tree that reached against the farther side of the flower-stand, disappeared from our ken forever.

THE USES OF ANIMAL COLOR.*

By EDWARD B. POULTON, M. A., F. R. S.

COLOR, as such, is not necessarily of any value to an organism. Organic substances frequently possess a chemical and physical structure which causes certain light-waves to be absorbed; or, the elements of tissues may be so arranged that light is scattered, or interference colors are produced. Thus blood is red, fat is white, and the external surface of the air-bladder in certain fishes has a metallic luster, like silver. In such cases there is no reason why we should inquire as to the use or meaning of the color in the animal economy; the color, as such, has no more meaning than it has in a crystal of sulphate of copper or iron. Such colors are the incidental results of chemical or physical structure, which is valuable to the organism on its own account. This argument will be still further enforced if we remember that the colors in question are, strictly speaking, not colors at all. Blood and fat are so constituted that they will be red and white, respectively, in the presence of light, but they can not be said to possess these colors in their normal position, buried beneath the opaque surface of an animal.

* From advance sheets of The Colors of Animals, by Edward B. Poulton, M. A., F. R. S. International Scientific Series, No. LXVII. In press of D. Appleton & Co.

The existence of non-significant colors is, nevertheless, most important, for they form the material out of which natural or sexual selection can create significant colors. Thus the color of blood may be made use of for "complexion," while fat may be employed to produce white markings, as in certain insect larvæ. The yellow, brown, and red fatty matters of the connective tissue are accumulated beneath the skin in patches, so as to produce patterns.

All animal color must have been originally non-significant, for, although selective agencies have found manifold uses for color, this fact can never have accounted for its first appearance. It has, however, been shown that this first appearance presents no difficulty, for color is always liable to occur as an incidental result. This is even true of the various substances which seem to be specially set apart for the production of color in animals; for pigments occur abundantly in the internal organs and tissues of many forms. The brilliant colors of some of the lower organisms are probably also non-significant. In all higher animals, however, the colors on the surface of the body have been significant for a vast period of time, so that their amount, their arrangement in patterns, their varying tints, and their relation to the different parts of the body, have all been determined by natural selection through innumerable generations. Because the origin of all pigments is to be found in the incidental result of the chemical and physical nature of organic compounds, it by no means follows that incidental or non-significant colors would have appeared at all on the surface of most animals. And we find as a matter of fact that such colors tend to disappear altogether, directly they cease to be useful, as in cave-dwelling animals. On the other hand, the non-significant color of blood or of fat would persist undiminished in such forms.

Just as natural selection may develop an appearance which harmonizes with the surroundings, out of the material provided by non-significant color, the same agency may lead to the disappearance of the latter when it impedes the success of an animal in the struggle for existence. Thus the red color of blood has disappeared in certain transparent fishes, which are thereby concealed from their enemies. Among the manifold possible variations of nature is that of a fish with colorless blood, which can, nevertheless, efficiently perform all the duties of this fluid. While such a variation would be no advantage to the great majority of vertebrates, it would be very beneficial to a fish which was already difficult to detect on the surface of the ocean on account of its transparency.

Colors may be useful in many ways, and are therefore always liable to be turned to account in one direction or another. They

may be of direct physiological value to the organism, or may assist in the struggle for existence by deluding other species, or by aiding the individuals of the same species, or they may be intimately connected with courtship.

The color of chlorophyl, which causes the green appearance of vegetation, must be intimately connected with the important changes which take place in this substance in the presence of light. It is well known that under these circumstances carbon dioxide (popularly called "carbonic acid") can be split up, and its carbon made to unite with the elements of water, forming organic substance. Although this process has been much studied, it is still very imperfectly understood. It is clear, however, that the color of chlorophyl, involving the special absorption of certain light-waves, has some direct bearing upon the changes which occur.

No equally clear instance has been proved to occur in the animal kingdom, except in those few forms which resemble plants in possessing chlorophyl. Dr. Hickson, however, believes that among corals "the most widely distributed colors will eventually be proved to be allied to chlorophyl, . . . and perform a very similar if not precisely identical physiological function." It is much to be desired that this interesting suggestion, which Dr. Hickson supports by many arguments, may be thoroughly tested as soon as possible.*

In the very common association of colored substances with the important function of respiration, it is clear that the color is not more than incidental; while the fish with transparent blood shows that color is not indispensable for the due performance of the function. Pigment is, however, of direct importance for vision; it is always present in the eyes of animals, except in the case of albinos, and it is said that even they possess the essential visual pigment associated with the termination of the optic nerve (retinal purple).

The difference between the physiological importance of color in animals and plants is well shown by the fact that a true albino variety (not merely a variegated example) of a green plant could not live for any length of time.

There are, however, certain cases among animals in which it is extremely probable that color is of direct physiological value. It is well known that dark colors readily absorb radiant heat, while light colors do so with difficulty. For this reason black clothes are most trying, and white most comfortable, in the hottest weather. Conversely, a dark surface readily parts with heat by radiation, while a white surface retains heat far more effectually.

A few writers had suggested that these principles may explain

* A Naturalist in North Celebes (Hickson, 1889), pp. 149–151.

the colors of certain animals, but the question was first fully entered upon in Lord Walsingham's presidential address to the Yorkshire Naturalists' Union in 1885.* The predominance of *dark* varieties of insects and *white* varieties of birds and mammals in northern latitudes is connected with these facts. "Birds and animals living through the winter naturally require to *retain* in their bodies a sufficient amount of heat to enable them to maintain their existence, with unreduced vitality, against the severities of the climate. Insects, on the contrary, require *rapidly to take advantage* of transient gleams of sunshine during the short summer season, and may be content to sink into a dormant condition so soon as they have secured the reproduction of their species; only to be revived in some instances by a return of exceptionally favorable conditions."

It would be fatal for the temperature of one of the higher vertebrates to sink a few degrees below the normal, except in the case of certain species, such as the dormouse, etc., which have the power of hibernating in a dormant condition; such animals were once called "warm-blooded," but are now more correctly termed "homothermic," because it is the *constancy* of the temperature which is so important, and which must be maintained whether the surrounding medium be colder or warmer than themselves. Other animals with an inconstant temperature are now correctly called "poikilothermic" rather than "cold-blooded."

Lord Walsingham's conclusions appear to be supported by the fact that young dark-colored caterpillars, like those of the emperor moth (*Saturnia carpini*), or tortoise-shell butterfly (*Vanessa urticæ*), seek the light side of a glass cylinder, and always change their position when the cylinder is turned round. The question needs further investigation, and much might be learned by interposing various screens between such larvæ and the light, thus cutting off different sets of light-waves.

The most important support to the hypothesis is found in an experiment made by Lord Walsingham, in which several *Lepidoptera* of different colors were placed on a surface of snow exposed to bright sunshine; in half an hour the snow beneath the darker insects showed distinct signs of melting, but no effects were seen beneath the others. The differences were further brought out in the course of two hours, when the darkest insect of the lot, a black geometer, the chimney-sweeper (*Odezia chærophyllata*), "had decidedly won the downward race among them."

It is therefore certain that the absorption of radiant heat is favored by the dark colors of northern insects, and it is in every way probable that they are benefited by the warmth received in

* See Entomological Transactions of the Union for 1885.

this way. We can not, however, as yet assert that such dark colors are not also advantageous for concealment or some other purpose.

The white appearance of arctic birds and mammals must be advantageous for concealment in a region so largely covered with snow, but it is very probable that advantage is also secured by checking the loss of heat through radiation.

Thus Lord Walsingham's experiments and conclusions seem to prove that colors are sometimes of direct physiological value to animals, although a great deal more work must be done before we can safely estimate the proportion which this advantage bears to others also conferred by the same colors.

By far the most wide-spread use of color is to assist an animal in escaping from its enemies or in capturing its prey; the former is *protective*, the latter *aggressive*. It is probable that these were the first uses to which non-significant colors were put. The resemblances are of various kinds; the commonest cases are those of simple concealment. The animal passes undetected by resembling some common object which is of no interest to its enemies or prey respectively, or by harmonizing with the general effect of its surroundings; the former is *special*, the latter *general resemblance*, and both may be *protective* or *aggressive*. Among the most interesting *special aggressive resemblances* are the cases of *alluring coloring*, in which the animal, or some part of it, resembles an object which is attractive to its prey.

Mimicry is in reality a very important section of *special resemblance*. The animal gains advantage by a superficial resemblance to some other, and generally very different, species which is well known and dreaded because of some unpleasant quality, such as a sting or an offensive taste or smell, etc., or it may even be protected from the animal it resembles: this is *protective mimicry*. When, however, the animal resembles another so as to be able to injure the latter or some other form which accompanies it or is not afraid of it, the *mimicry* is *aggressive*. . . .

When an animal possesses an unpleasant attribute, it is often to its advantage to advertise the fact as publicly as possible. In this way it escapes a great deal of experimental "tasting." The conspicuous patterns and strongly contrasted colors which serve as the signal of danger or inedibility are known as *warning colors*. In other cases such colors or markings enable individuals of the same species easily to follow those in front to a place of safety, or assist them in keeping together when safety depends upon numbers. It is these *warning colors* which are nearly always the objects of *protective mimicry*.

Finally, in the highest animals, the vertebrata and many of the most specialized invertebrate groups, we have some evidence for the existence of an æsthetic sense. Darwin believed that this

sense was brought into play in courtship, and that colors and pattern have been gradually modified by the preference of the females for the most beautiful males; he believed that such *sexual selection* accounts for many of the most beautiful features possessed by animals, viz., those which are especially displayed during courtship.

THUNDER-STORMS.

By ROBERT H. SCOTT.

THUNDER-STORMS naturally attract universal attention when they occur, and it may perhaps be of interest to point out some particulars that have been ascertained about them.

The most obvious facts are that a heavy cloud passes over the observer, and that from it lightning appears, followed, after a greater or less interval, by thunder; and that usually heavy rain or hail falls from the cloud. The damage wrought by these occurrences, whether by lightning-strokes or by the hail, is so serious that, in countries especially liable to such visitations, hail insurance forms an important item in the farmer's calculations. In many countries such insurance is in the hands of the Government, and accordingly statistics as to the amount of losses are to be obtained; whereas where insurance is in the hands of private companies, information as to the expenditure of these companies is naturally not published.

As regards the liability of certain districts to suffer damage from thunder-storms, it has been maintained by several authorities that these visitations are steadily increasing in frequency. A most elaborate inquiry into the records of such occurrences was printed in the Journal of the Statistical Office of Berlin for 1886. From this it appears that the evidence indicated no general increase in the frequency of lightning-strokes, but, on the contrary, rather a decrease. Houses with soft or, in other words, thatched roofs are struck about seven or eight times more frequently than ordinary slated dwelling-houses. Houses in towns are much less frequently affected than those in the country.

The geological character of the soil has a very great influence on the risk. If this for a limestone soil be taken as one, that for a sandy soil is nine, and for swampy land twenty-two. As regards the different classes of trees, if the risk to a beech be taken as one, that to a conifer (fir or spruce) is fifteen, to an oak fifty-four, and to other deciduous trees forty. Another investigator accounts for the comparative immunity of the beech by the fact that its leaves are edged with short hairs, which allow the electricity collected in the leaves to escape quietly.

As to the actual origin of atmospheric electricity, authorities

are not at all agreed, and the observations made on its phenomena (made at different stations) do not accord in a satisfactory manner. In fact, it appears as if the indications of the instruments are due to local causes, so that they do not lend themselves to any useful generalizations. When a thunder-storm is actually raging in the neighborhood of a station, the indications of electrometers thereat are most erratic and violent, but it can not be said that any electrometer enables us to perceive the approach of a storm one whit earlier than we are able to do by careful watching of the clouds. As regards forecasting thunder-storms, this can be done in a general sort of way; but it is not practicable to predict which villages or parishes, or even counties, will be visited. When the daily weather charts are drawn, if we find that there is an unevenness in the isobaric lines—that is, if these are wavy, or bulge out irregularly—we know that thunder-storms are likely to burst somewhere or other over the country, but that is all we can say. At each station the barometer is unsteady—the mercury moving up and down in the tube—during the actual continuance of the storm; but this oscillation of the mercurial column has nothing to do with the irregularity in the isobaric lines above mentioned. Forecasting these storms is, therefore, always an uncertain and a thankless task, for local success is rarely attained.

Among the earliest symptoms of the approach of a thunder-storm is the appearance on the western horizon of a line of *cumulus* ("wool-pack") clouds, exhibiting a peculiar turreted structure. I say on the western horizon, for most of our changes of weather come from that quarter, and it has been proved that thunder-storms, like wind-storms, advance over the country, generally, from some westerly point. This bank of clouds moves on, and over it appear first streamers and then sheets of lighter upper cloud—*cirrus*, or "mare's-tail"—which spread over the sky with extreme rapidity. The heavy cloud mass comes up under this film, and it is a general observation that no electrical explosion or downfall of rain ever takes place from a cloud unless streamers of *cirrus*, emanating from its upper surface, are visible when the cloud is looked at sideways from a distance.

Thunder-storms are generally accompanied by falls of hail as well as rain, and these hailstones assume the form of lumps of ice —some even as large as hens' eggs, and weighing several ounces, having been known to fall. The stories of masses of hailstones, weighing many pounds, having been found after storms, are explained by the fact that the hailstones, after they have fallen, may have frozen to each other and formed a solid lump on the ground. Large hailstones are composed of alternate layers of clear crystalline and white porous ice, and many of them consist of an aggregate of smaller hailstones which have attached them-

selves to one stone as a nucleus, and then the mass so formed has received external coatings of ice. The compound structure of such stones becomes manifested when the mass gradually thaws. In some cases these stones are coated with crystals of ice in six-sided prisms and pyramids, as perfectly formed as the specimens of quartz or calc-spar crystals which are to be seen in mineral collections. It is very hard to believe that such beautifully formed crystals as these can be the product of any instantaneous process of formation.

It is these heavy blocks of ice which do the greatest amount of damage, as naturally a lump, weighing even an ounce, is a formidable missile when it falls from a height of even a thousand feet. When these falls are about to take place, observers have reported that a peculiar rattling sound is heard in the atmosphere, evidently from collisions between these stones striking one another in their fall. A very careful observer, who was overtaken by one of these falls in the Caucasus, near Tiflis, states that it occurred immediately after an ordinary hail-shower, and that he could see the successive showers marching over the country, and noticed that, between the last edge of the falling hail and the front edge of the falling ice-blocks, there was a distinct break, through which he could see the sun shining on the hills in the background. It was on this particular occasion that the best specimens of crystal-bespangled hailstones have been recorded and sketched, but others have been reported from Natal, and quite recently from Philadelphia, October 1, 1889. When such a visitation of ice-lumps takes place, the entire crops of the district affected by it are destroyed. Such a storm passed over Richmond in August, 1879, and in five minutes some ten thousand pounds' worth of damage was done, principally to conservatories. Naturally, Kew Gardens were among the principal sufferers.

It is a problem as yet unsolved to account for the suspension in the atmosphere of such objects as these hailstones, which frequently weigh much over an ounce. A recent theory, which seems to carry some probability with it, supposes that in the heart of every hail-cloud there is a whirlwind, or what is usually but erroneously termed a "tornado." It is well known that such disturbances exert a prodigious lifting power, raising heavy objects, such as carts, house-roofs, and even trees, and transporting them to considerable distances. The theory is, that when a drop of water in such a cloud is congealed it is carried round and round in the vortex and lifted up, more moisture being condensed and frozen upon it at each gyration, until at last it is thrown out and falls. This would account for the alternate layers of which I have already spoken, but will not account for the formation of crystals, a growth which usually requires a considerable time.

Thunder-storms have been scientifically studied in various countries, and the broad fact has been elicited that they travel over the earth's surface like wind-storms, but at a higher velocity. To give an idea of this, I may quote some statements made before the Royal Meteorological Society last June, in relation to the storm of the 2d of that month. This storm progressed from Wiltshire to Edinburgh, over a distance of four hundred miles, at a nearly uniform speed, the rate of travel being about fifty miles an hour. This is an unusually rapid rate of advance for a wind-storm over these islands. I am not speaking of the velocity of the wind in the storm, but of the velocity of the storm system as a whole. In this storm many of the hailstones which were collected weighed over an ounce. Some at Docking, near King's Lynn, were said to be three inches in diameter, and to weigh three and a half ounces. One was weighed at Barden Mill, near Tunbridge Wells, and was said to turn the scale at half a pound. As regards the incessant character of the lightning in London, one observer at Highgate counted twelve hundred and forty-four displays during the two hours ending at 11.10 P. M., giving an average of over ten per minute. Another observer, at Westgate-on-Sea, gave a much higher figure for frequency; his attempt to count breaking down at the very high number of one hundred and thirty-one per minute.

Thunder-storms are much more frequent in low latitudes than in high. In some tropical countries they are said to occur regularly every afternoon. At Rio the story was that at certain seasons, in issuing invitations to afternoon parties, it was usual to specify whether guests were to assemble before or after the thunder-storm. In Abyssinia, D'Abbadie gives, as the average of four years, 410·6 as the annual number of these storms. Many of these, however, consisted of only one or two flashes of lightning. It was formerly believed that such storms never were noticed in the arctic regions, but this is not the case, for one was experienced at Bell Sound, Spitzbergen, in 78° north latitude, in August, 1873; and a succession of thunder-storms was reported for several days in July, 1870, on the west coast of Nova Zembla. At any rate, in such high latitudes they are very rare.

Thunder-storms are generally divided into two groups—heat thunder-storms and cyclonic thunder-storms. The former are the summer type, while the latter occur principally in autumn and winter. We may also say that the former are essentially continental, while the latter are characteristic of the ocean or island climate. In Iceland all the thunder-storms are of this latter type, and occur in winter. The same conditions show themselves on the British Atlantic coasts, where there is a decided maximum of frequency of such storms in winter, even in the latitude of the south-

west of Ireland, at Valencia. These circumstances are accounted for by the fact that thunder-storms are always associated with great differences of temperature in adjacent masses of air. Such conditions are most likely to occur in hot climates, where the soil gets excessively heated in the daytime, while the air at some distance above it is cool. In cold climates they occur in winter, where a shift of wind from southwest to northwest is sometimes accompanied by a sudden fall of temperature of 15° or even 20°.

We of the British Islands owe our comparative immunity from thunder-storms to our damp climate. The fact is well known that it is comparatively difficult to perform any electrical experiments in these islands, and that all apparatus must be kept constantly in front of a fire in order to prevent moisture being deposited on it. Accordingly, we must suppose that the electrical disturbances which would give rise to explosions and severe storms in France or Germany may pacify themselves comparatively quietly in our atmosphere, and at most only give rise to phenomena of a very moderate character.

I must now say something about the actual lightning flash, which is neither more nor less than a violent electric spark. Three different forms of lightning are generally admitted to exist: (1) The actual flash, or what is commonly called "forked lightning." (2) "Sheet lightning," which usually is the illumination of the sky by a lightning flash which takes place below the horizon. (3) "Globular lightning."

1. As to the term "*forked lightning*," the representations of it given by artists, which resemble the so-called thunderbolts placed in the hand of Jupiter, are quite absurd. The flash, when photographed, exhibits itself as a line which is continually changing its course, and is described as "intensely crooked" by a very careful observer. It never proceeds for a time in a straight line, and then, turning at a sharp angle, going on farther in an equally straight line, as is represented in pictures. The forking of it is very marked, and this occurs by side flashes passing off from the main track, and eventually losing themselves, like the ramifications of tree-roots. Occasionally the lightning appears to start from a point from which several flashes diverge in different directions.

2. "*Sheet Lightning.*"—Whenever a flash passes from cloud to cloud, or from cloud to earth, the light produced by it illuminates the sky in the neighborhood, and the more intense the flash, the more brilliant and extensive the illumination. At times sheet lightning has been proved to emanate from an ordinary storm distant more than a hundred miles from the point of observation. It is, however, maintained, and apparently with good reason, that occasionally lightning of the "sheet" type, such as what is called

"summer lightning," takes place without any thunder; so that, in such cases, no actual thunder-storm is in progress.

3. "*Globular Lightning.*"—This is a rare phenomenon, and one which no one has as yet been able to produce in the laboratory, whereas the phenomena of the two previous types are easily produced. The general description of the occurrence is that a luminous ball is seen, moving very slowly, not touching any object, and eventually breaking up with a violent explosion and the appearance of several flashes of ordinary lightning. It is reported that persons have gone out from a house into a street to follow such a ball and watch its movements, so that the occurrence must have lasted at least a number of seconds. Ordinary lightning, as is well known, is practically quite instantaneous. The size of the ball on different occasions has varied from that of an orange to that of a large glass lamp-globe, or even larger. Many physicists refuse to believe any accounts of this manifestation of the electrical discharge, but the reports of it are too numerous and circumstantial for us to consider them to be entirely baseless.

There is another way of classifying lightning flashes, and that is as to their color. The seven colors of the solar spectrum are well known, but the spectrum of the electric spark differs materially from the solar spectrum. It exhibits rays which extend far beyond the extreme violet of the solar spectrum. We see, therefore, that in the light of lightning a wide range of color is possible. If any of my readers have ever watched a storm carefully, they must have noted that some of the flashes were bluish, others reddish, etc. It is generally the blue tints which accompany the most destructive strokes.

Some attempts have been made to estimate the actual force exerted by a lightning flash. The late Mr. de la Rue constructed a magnificent electrical battery of many thousand cells. From experiments with this, the number of cells being raised to 15,000, and the "potential" of each being rather over one "volt," it was found that 9,700 "volts"—say 9,500 cells—were required to produce a discharge through one centimetre (·3937 inch). Starting from these data, the electro-motive force requisite to produce a flash of lightning one mile (63,360 inches) in length, at ordinary pressures, is 1,480,570,000 volts, practically given by a battery of fifteen hundred million cells.

A flash a mile in length is nothing very extraordinary, and it is therefore not to be wondered at that experiments to bring electricity down from the clouds are very dangerous, and have frequently had fatal results. Soon after Franklin, in the last century, had made his famous experiment with a kite, and proved that electricity existed in a thunder-cloud, natural philosophers generally began to imitate him. One of them in St. Petersburg, a

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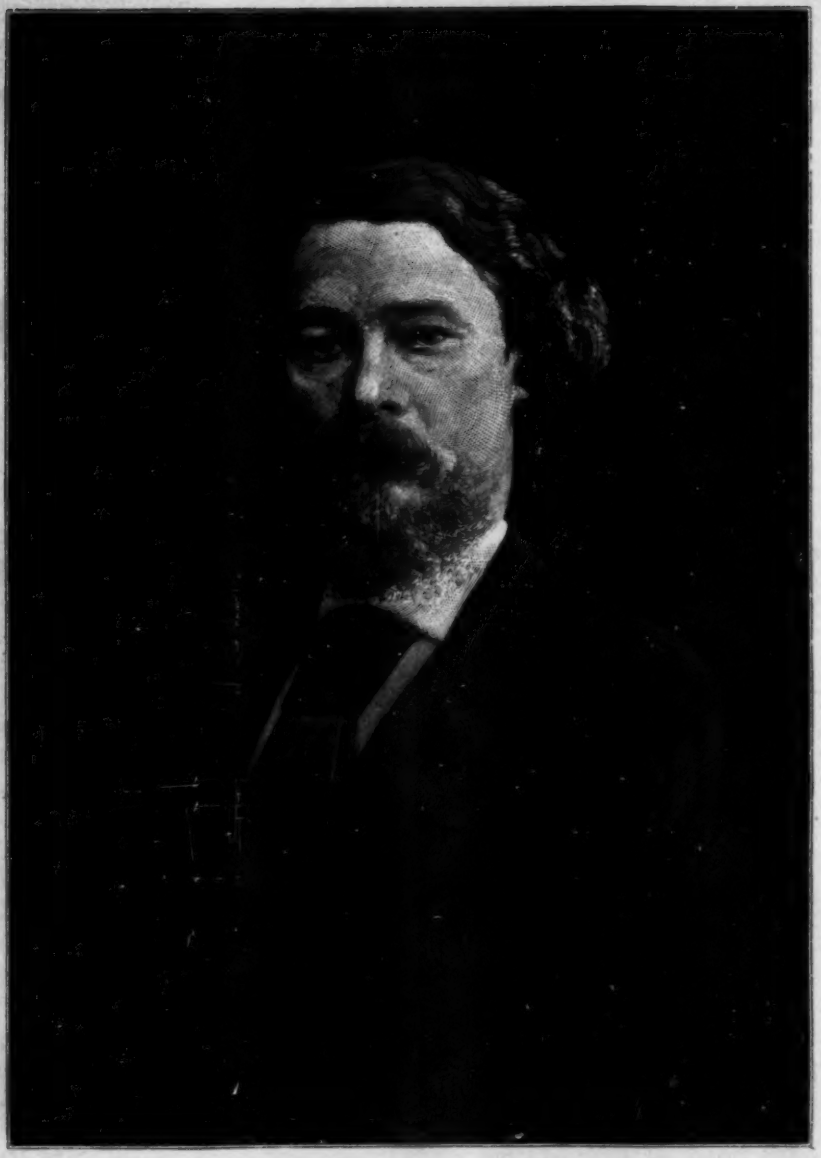
Prof. Richmann, arranged an apparatus to collect this electricity. On the first occasion of a storm he went to his laboratory to observe the effects. A ball of fire was seen to leap from the apparatus to his head, and he fell lifeless.

A flash of lightning really consists of a discharge between two objects, say two clouds, or a cloud and the earth, oppositely electrified, the charges on which suddenly combine, with the manifestation of light and heat. Lightning conductors are contrivances by which the electricity of the earth is allowed to escape quietly into the atmosphere, where it meets with electricity of the opposite character from the clouds, and the two neutralize each other quietly, without any explosive discharge, or, in other words, without lightning. I need not go back to the first principles of electrical science and explain why it is that electricity passes most easily through metals, and escapes with greater freedom from sharp points than from rounded knobs. Assuming these elementary facts, I may say that on any object, such as a house or other building, the electricity tends to accumulate itself on all projecting portions of the roof, etc., and especially on the highest points of it. The ideal complete lightning-rod system would call for a sharp-pointed copper rod erected at each of these projecting pinnacles, and rising above it, and would then connect all these separate points by copper rods, and eventually carry down a stout copper rod to the earth. Care must be taken that due attention is paid to certain main precautions: (1) The point of the conductor must be kept sharp; (2) the section of the conducting rod must be sufficient to allow the electricity to pass along it; (3) the rod must be perfectly continuous; and, lastly (4), the rod must be efficiently connected with the ground.

1. The sharpness of the point is insured by gilding it or coating it with some metal which resists oxidation.

2. As to the section of the rod, a bar half an inch in diameter is sufficient for all ordinary buildings. Bars are not usually employed, as it is difficult to bend them over cornices, etc.; accordingly, either wire ropes or tapes are taken. The wire ropes are more liable to corrosion from wet getting in between the strands than are tapes, so that the latter are generally preferred.

3. The continuity of the metallic connection from the highest point of the rod to the ground can only be secured by having as few joints as may be, and by making those joints as true and firm as possible by soldering. The joints should be examined from time to time, for it is often found, on examination of old conductors, that while the copper wire or tape is quite sound along its straight reaches, at the bends or joints corrosion has set in. As a chain is no stronger than its weakest link, a corroded conductor, such as has been described, is perfectly useless.



RUDOLPH KOENIG.

4. *The Earth Connection.*—It is not easy in all cases to insure that this is satisfactory. Electricity will not pass at all so easily into dry earth as into wet earth, and merely plunging the end of the rope or tape into wet earth is not sufficient. The conductor from the building should be soldered at its end to a large sheet of copper, say at least two square yards in area, buried in damp soil, or else soldered to the water or gas mains, so as to insure that a large surface of metal is in contact with damp earth.

Supposing that the whole system of protection against damage from lightning has been properly planned, the work should be carefully tested after its completion, because injury to it often occurs at the very last, owing to accidental causes, or to the carelessness of workmen. Conductors should also be examined from time to time, throughout their whole length, to make sure that all the joints are sound. Care should also be taken that the earth in which the terminating plate is buried is kept thoroughly moist. If any of these particulars be neglected, the conductor will be practically useless, and will afford no protection to the structure. —*Abridged from Longman's Magazine.*

SKETCH OF RUDOLPH KOENIG.

By Professor W. LE CONTE STEVENS.

IN examining the personal records of men who have contributed to the advancement of human knowledge, one of the features most frequently noticed is the necessity to meet adversity in early life. Perhaps it is but little less frequently the case that they are compelled throughout life to content themselves with a minimum of pecuniary reward for the mental work which meets due appreciation only after its final close. The thirst for discovery, the craving after truth, apart from all considerations of emolument, exist germinally in every young human being; but the rewards that the world gives for brain-work, other than what is directed toward the discovery of truth, are sufficient to determine most men and keep them occupied in fields other than scientific. Native bent, if fortified with force of character, finds its channel in time, whatever may be the accidents of childhood; and uncongenial occupation has been the lot of many who have used it as the basis of future renown.

Quite a number of those who have achieved distinction in physical science have, in early life, or throughout life, given a considerable share of attention to the mechanical details involved in constructing the instruments needed for investigation. Newton began in youth the making of machines, and his skill as a

practical optician was only less remarkable than his genius as a mathematician. Herschel practiced music as a profession, while giving all his spare time to the grinding of telescope mirrors and to observational astronomy. Ruhmkorff wandered to Paris as a boy of sixteen, and became a porter in the laboratory of a French physicist. In time his name became known wherever the induction coil is used, whether in the investigations of the physicist or in the operations of commercial electricity. Wheatstone adopted the vocation of a maker of musical instruments in preference to grinding Greek and Latin verses at school. This work he continued for many years, achieving world-wide distinction as an original investigator in acoustics, and afterward in optics and electricity.

Younger than Ruhmkorff and Wheatstone, but amply worthy of being classed with them, is RUDOLPH KOENIG, the most distinguished living inventor and mechanician in the domain of acoustics. He was born on the 26th of November, 1832, in Koenigsberg, Prussia. His father was teacher of mathematics and physics in the city gymnasium, where the son as pupil received the usual high-school training, corresponding in some particulars to the academic work in most American colleges. He exhibited much aptitude in physics as well as music; but, being compelled to depend upon his own resources, he went to Paris at the age of nineteen years, to devote himself to the construction of stringed instruments. Here he worked for several years under the direction of the celebrated violin-maker Vuillaume, but at the same time devoted such leisure as he could command to the study of mechanics and physics.

Quite naturally acoustics was the branch of physics which presented most attraction to the young mechanician, and in time it claimed his almost undivided allegiance. Meanwhile his success was such as to warrant him in undertaking business on his own account, so that in 1858 he fitted up a working place for the construction of acoustic apparatus, and in 1859 he issued his first catalogue, containing descriptions and illustrations of the various instruments made by him. Some of these were improvements upon instruments already in use, but many were new, the outcome of Koenig's own ingenuity. This catalogue formed the basis of the subsequent expansions which appeared in 1865, 1873, 1882, and 1889. The last is a volume of one hundred pages, with descriptions of two hundred and seventy-two instruments, in French, English, and German, and including probably everything that is employed in modern acoustic investigation.

It was in 1862 that Koenig began to be known to the scientific world as an investigator. An International Exhibition was held during that year in London, and the indefatigable instrument-maker was present, not merely for the purpose of displaying the

products of his labor, but to use these in the presence of physicists and to show practically the value of the graphic method of studying harmonic motion which had grown almost to perfection in his hands. The mathematical analysis of wave-motion had been abundantly brought out in technical treatises. Dr. Thomas Young, in the beginning of the present century, had pointed out the method by which a tuning-fork might be made to trace a record of its own vibrations, and his hint was put into practice nearly half a century afterward by Wertheim and Duhamel. But Koenig was the first to apply this method systematically to the registration of not only simple vibrations but also compound harmonic motion; and a large variety of such phonograms executed with apparatus of his device, and accompanied with the tracings of the corresponding theoretical curves, attracted much attention at the exhibition. The method has since been adopted in a number of other fields, notably in physiology for the analysis of animal motion, and in general physics for the measurement of minute intervals of time.

At the same exhibition in 1862 Koenig exhibited a wholly new method of making the effects of sonorous vibration easily visible by utilizing the delicate sensitiveness of flame to variations of atmospheric pressure. Four years earlier some noteworthy experiments had been made in America by Le Conte on the effect of such vibrations upon naked gas-flames; but no development had thus far been evolved from them. Koenig devised the manometric capsule through the medium of which the pressure at the outflowing jet is modified at will by sound-waves conducted to an elastic membrane. The motion of this produces pulsations in the gaseous fuel, and their effect on the flame is observed by looking at its image reflected from a revolving mirror. This beautiful method has been applied by its originator with much success to the study of the interference of sound, and to the investigation of the quality of musical sounds. No two vowels can be sung in succession to the delicate flame without impressing on it their separate individuality; and the eye is thus permitted to compare differences which the ear may recognize but not analyze. To see one's own voice in a mirror, to watch the successive phases of melody and harmony, to see two sounds interfering and producing visible silence—these are some of the revelations of the manometric flame.

This remarkable exhibition of Koenig's originality brought him prominently into notice everywhere. A detailed description of his work was published soon afterward by Prof. Tisko in Vienna, and from that day to this he has had no rival in the field which he had made his own. In every university where acoustics is taught Koenig's apparatus is the standard. Honors also were

soon accorded in acknowledgment of his merit. Among these may be mentioned a gold medal, in 1865, from the Société d'Encouragement at Paris; a gold medal, in 1867, from the International Exhibition at Paris; in 1868 the honorary degree of Doctor of Philosophy, from the university of his native city, Koenigsberg; and, in 1876, a medal from the Centennial Exhibition at Philadelphia. Before scientific assemblies he has been called upon to give the results of his investigations, including in them the Assembly of German Naturalists, in 1868, at Dresden; the American Association for the Advancement of Science in 1876 at Buffalo, and again in 1882 at Montreal; and the Electrical Exhibition at Paris in 1881, when he was specially visited by a large company of the most renowned of living physicists, including Helmholtz, Kirchhoff, Du Bois-Reymond, Clausius, Quincke, Mach, Kundt, Pahlzon, and Sir William Thomson.

The scientific papers of M. Koenig have been published almost entirely in the Annalen of Poggendorff and of Wiedemann. Most of these have been translated into French and published, in 1882, in a volume entitled Quelques Expériences d'Acoustique. To give an adequate idea of what is included in them would be impossible without going into detail. The volume includes a full account of Koenig's application of the graphic method and that of manometric flames. Both these methods are applied in an exhaustive investigation of the beat tones which result from the combination of two or more primary tones. Helmholtz discussed "differential tones" and "summation tones," whose existence was inferred from the results of mathematical analysis; and certain phenomena seemed for a time to confirm the conclusions of the great German physicist. But Koenig subsequently applied the most patient care and consummate skill in the experimental examination of these phenomena. Without detracting at all from the credit due Helmholtz for his splendid researches, it may now be safely said that Koenig's experiments have shown that differential and summation tones are due exclusively to the beats which the ear perceives when impressed simultaneously by systems of waves differing in length. The effect is physiological, and such combination tones are not at all re-enforced by resonators like the separate primaries that enter into combination. It is not necessary that beating tones shall be nearly in unison, as is stated in so many of the text-books.

The subject of musical quality was long an unsolved enigma for physicists. The principle underlying its explanation was foreshadowed early in the present century by the French mathematician Fourier, and soon afterward applied to acoustics by Ohm, whose name is now so familiar in connection with electricity. But to Helmholtz is due the full experimental proof that the

quality of every musical sound is determined by the number, orders, and relative intensities of the upper partial tones which accompany the fundamental whenever any ordinary instrument is sounded. Every such compound tone can be graphically represented by its own curve, the form of which may be varied not only by varying the elements just mentioned, but also by varying the phases in which the separate components are joined together. Helmholtz endeavored to test the influence of change of phase in using his apparatus for acoustic analysis, but the results were negative, and his conclusion was, that variation in phase has no physiological effect. Koenig has since attacked this problem, employing wave-sirens of his own invention, by which he has established quite conclusively the existence of this fourth element of musical quality. . . . The wave-siren may be briefly described as an apparatus in which a blast of air is forced through a narrow cleft against the edge of a moving plate or disk on which a series of determinate wave-forms have been cut. Each sinuosity, as it passes the cleft, interrupts the egress of air, so that a series of compound pulses are propagated whose grouping is determined by the form of the curved edge. The pitch is determined by the speed of rotation and the wave-length cut in the metal, through either the convex surface of a cylinder which rotates on its axis, or the edge of a disk which rotates about its center. A number of such wave-forms, each with its own wind-cleft, may be operated at the same time, with the same speed and with the same pressure of air at each cleft. They may be arranged to either coincide or differ in phase to any required extent. By the use of this new instrument Koenig has found that the complex sound obtained by the composition of a series of harmonics, of even as well as odd orders, quite independently of their relative intensity, has always its maximum of strength and its greatest acuteness of quality for a difference of phase of a fourth of a wave-length; the minimum of strength, and the softest quality, for a difference of phase of three fourths of a wave-length. It may be said that, if changes in the number and relative intensity of the harmonics produce differences of quality, such as are observed in instruments belonging to different families, or such as the human voice shows in the different vowels, the changes due to difference of phase between the same harmonics are yet capable of producing differences of quality at least as sensible as those which are noticeable in instruments of the same kind, or in the same vowels sung by different voices.

All musicians are able to perceive the general smoothness or roughness of a combination of sounds; but the analysis of the combination requires exquisite sensitiveness of ear for the detection of variation in both pitch and harmony. In the tuning of the standard forks which are issued from Koenig's laboratory, his

ear is usually found to be a sufficient guide, and at standard temperature these are rarely if ever found to deviate by more than a fraction of a single vibration from the value stamped upon them.

Within the last year Koenig has published two important papers: the one on beat tones due to the excitement of two separate motions of vibration on the same body; the other on tones due to the composition of waves of unlike form. These papers have an important bearing on the theory of musical quality. Their author is not yet sixty years old, and it is reasonable to expect from him many more contributions to the science of acoustics before old age interferes with the acuteness of his wonderfully accurate musical ear, or diminishes his power to do good work.

The following is a list of the principal contributions of M. Koenig to science, with their dates and the names of the periodicals in which they first appeared. The titles are translated into English, and the length of each article is approximately indicated by the number of pages covered:

1. On the Application of the Graphic Method to Acoustics. (Cosmos, 1862, pp. 27.)

2. Apparatus for the Measurement of the Velocity of Sounds at Small Distances. (Comptes Rendus de l'Académie des Sciences, October 13, 1862, pp. 2.)

3. Experiments relating to Wheatstone's Explanation of Chladni's Figures. (Comptes Rendus, March 27, 1864, pp. 7.)

4. A New Stethoscope. (Poggendorff's Annalen, 1864, pp. 2.)

5. Experiments to determine the Influence of the Movement of a Source of Sound on Pitch. (Koenig's Illustrated Catalogue, 1865, p. 1.)

6. On the Fixed Notes characteristic of Vowel Sounds. (Comptes Rendus, April 25, 1870, pp. 5.)

7. Manometric Flames. (Poggendorff's Annalen, 1872, pp. 36.)

8. A Tuning-Fork of Variable Pitch. (Poggendorff's Annalen, 1876, pp. 2.)

9. On the Phenomena produced by the Concurrence of Two Sounds. (Poggendorff's Annalen, 1876, pp. 62.)

10. On the Origin of Beats, and the Beating Sounds of Harmonic Intervals. (Wiedemann's Annalen, 1881, pp. 14.)

11. Description of an Apparatus for Lecture Demonstration of Beating Sounds. (Wiedemann's Annalen, 1881, pp. 4.)

12. Researches on the Difference of Phase existing between the Vibrations of Two Associated Telephones. (Journal de Physique, May, 1879, pp. 5.)

13. Researches on the Vibrations of a Normal Fork. (Wiedemann's Annalen, 1880, pp. 21.)

14. Harmonic Vibrations excited by the Vibrations of a Fundamental Sound. (Wiedemann's Annalen, 1880, pp. 13.)

15. A Method for observing the Air Vibrations in Organ-Pipes. (Wiedemann's Annalen, 1881, pp. 12.)

16. Remarks on Musical Quality. (Wiedemann's Annalen, 1881, pp. 26.)

17. On Beats and the Beat Tones of Two Vibratory Motions excited in the Same Body. (Wiedemann's Annalen, 1890, pp. 8.)

18. On Composite Tones, with Waves of Unlike Form. (Wiedemann's Annalen, 1890, pp. 9.)

CORRESPONDENCE.

THE PROHIBITION LAWS OF IOWA.

Editor Popular Science Monthly:

SIR: In the May (1890) number of the Monthly Dr. W. A. Hammond, in his article on Sumptuary Laws, makes statements with reference to the prohibitory liquor laws of Iowa which are not only misleading but incorrect.

It is not an offense under our law "for one person to ask another to take a drink." It is not contrary to law in Iowa to give intoxicating liquor to an adult person not intoxicated nor in the habit of becoming so, when such gift is made without any consideration being received or expected in return, and without subterfuge or attempt to evade the provisions of the code. The act of giving intoxicating liquors, except to minors or habitual drunkards, is not prohibited by statute, and the Supreme Court has decided that the simple act of giving is no offense (State *vs.* Hutchins, 74 Iowa Rep., p. 20); and so in the case supposed by the doctor there is neither a violation of the letter nor the spirit of the law.

It may be added, however, as pertinent to the point made by the doctor, that Iowans may legally obtain all the liquor they want by importation from other States; and that, notwithstanding the most stringent laws against its manufacture and sale within the State, it is not difficult to purchase any kind of liquor either by the drink or by the bottle; and that it is at least doubtful if the drink habit is decreasing.

JAMES H. TREWIN.

LANSING, IOWA, *May* 13, 1890.

EVIDENCES OF GLACIAL ACTION IN VIRGINIA.

Editor Popular Science Monthly:

SIR: The interesting article in your June number, by the Hon. David A. Wells, on evidences of glacial action in southeastern Connecticut, recalls to my recollection the fact of similar evidence in the State of Virginia. Slightly north of latitude 38°, in the extreme southeast corner of Orange County (my native county), on a farm—originally, and I presume still, known by the name of *Wood Lawn*, or the Minor Farm—are two large bowlders, similar to those described by Mr. Wells. One of these bowlders is split in half; one half retains an erect position, while the other lies prostrate, forming a large, flat table. I speak of them as they appeared many years ago, although I presume their appearance is the same to-day. There are other bowlders of a like character in that vicinity, and, if they were visited and described by one competent to do so, a very interesting article might be written, and perhaps prove a valuable addition to the science of glacial action.

FRANCIS MINOR.

ST. LOUIS, *June*, 1890.

EDITOR'S TABLE.

MR. SPENCER'S PLACE IN PHILOSOPHY.

AS we had occasion not long ago to remark, the philosophy of evolution is a great stumbling-block and rock of offense to transcendentalists—that is to say, to people who want a philosophy founded on emotion and soaring beyond all experience into the region of the absolute. If such people do not like the evolution philosophy, it is natural that they should dislike the evolution philosopher *par excellence*, Mr. Spencer. His name seems to send a chill through those whose ambition it is to discover truth by some royal road of *a priori* assumption; and now and again these persons take courage to express all the repugnance they feel to what they regard as his desolating doctrines. Occasionally, also, though not very often, an attempt is made to show that Mr. Spencer is not so much of a philosopher after all—only a kind of all-round writer on a great variety of subjects, in not one of which he has any superior competence. Many of our readers will remember that some weeks ago a certain person wrote to the New York Times to express his own low estimate of the value of Mr. Herbert Spencer's philosophical work, and his grave doubts as to the rank assigned to him in the world of thought by really competent judges. This gentle-

man, who modestly signed "Outsider," had not been able to find that mathematical specialists thought very highly of Mr. Spencer as a mathematician, or that specialists in biology ranked him high as a biologist, or that men eminent for their historical knowledge regarded him as an authority in their special department, and so on and so on. Evidently this writer had somewhat singular notions as to what was required to make a philosopher. Not only is it impossible that Mr. Spencer should be a specialist in all the branches of knowledge upon which his system has a bearing, but it is quite unnecessary that he should be such in even one branch. His specialty consists in his power of co-ordinating the general results of different lines of inquiry; and his claim to rank as a philosopher depends on the success with which he has accomplished this task. All that can properly be demanded of Mr. Spencer, or any philosopher, is that he shall not misunderstand or misstate the results of the special sciences with which he may have to deal. If "Outsider" had been in a position to declare that mathematicians had examined Mr. Spencer's work, and found it very faulty on the mathematical side; that biologists, in like manner, had found it weak on the biological side; and that in general his system was, to a serious extent, based upon erroneous conceptions of special facts and laws, he would have made a very damaging criticism. He did not pretend, however, to be in a position to do anything of the kind; but simply attacked Mr. Spencer for not being, what no one man could possibly be, a specialist in half a dozen sciences at once.

The principal result of "Outsider's" attack was that a number of persons came forward, many over their own signatures, to vindicate Mr. Spencer; and so effectually was the work done, and such a revelation did the whole controversy afford of the hold Mr. Spencer had upon the thinking men of this country, that a very suspicious person might have conjectured that "Outsider's" secret object had been to get as much good said of Spencer as possible, and bring him and his works into greater prominence than ever. The personal interest which we have for years felt in the great English philosopher—an interest which the sketch of the late Prof. Youmans, published a couple of months ago in this magazine, will in some measure explain—led us to attempt in the columns of the Times a concise yet comprehensive statement of the testimonies that had been borne to the value of his scientific and philosophical work by the very highest authorities. "Outsider" had asked what the specialists thought of Mr. Spencer; we had no difficulty in showing what the men who commanded the widest view of the fields of philosophy and science, and who in that sense were the specialists by whom his work should be tried, thought of him. In philosophy, the names cited were such as Lewes, McCosh, J. S. Mill, Morell, and Ribot; in biology, such as Mivart, Ray Lankester, Huxley, Darwin; and in general science and history, Masson, Proctor, Tyndall, Grant Allen, Leslie Stephen, and Tylor. All of these, at one time or another, have in the amplest manner borne testimony to Spencer's philosophic genius, to the acuteness of his thought, the depth of his insight, the fertility of his methods, the sagacity of his judgment, the keenness and truth of his scientific perceptions—one remarking upon this quality or group of qualities, and another upon that. As further evidence of the impression Mr. Spencer has made upon his age, we gave the leading facts relating to the reproduction of his works in foreign countries and their translation into foreign tongues. In Russia, in Italy, in France, in Germany, Spencer's works may be read in the national tongue, and have powerfully molded philosophical opinion. The facts thus brought forward were not far to seek:

any one even moderately acquainted with the course of modern thought can hardly fail to know that these things are so; and it is difficult to understand how a writer vouched for by the Times as a person of very superior acquirements could have managed to remain ignorant of them. Possibly he is one of those "specialists" whose information is so very special that virtually they may be said to go about with blinkers over their eyes that shut out all side views. But in that case the man who wears the blinkers should not constitute himself a judge of what he does not and can not see.

Another objection which our critic raised was that the laws of evolution embodied in Mr. Spencer's system had never served as the basis for prediction, and so far lacked full confirmation. This criticism was singularly pointless. Prediction, in the sense understood in the sciences say of astronomy and chemistry, is not to be expected in connection with a general system of philosophy—the aim of which is to correlate diverse phenomena under a few very general laws. In another sense Mr. Spencer's system does lend itself to prediction, inasmuch as it has traced for us the laws of development of the individual mind and of society, and so far enabled us to anticipate what would fall under our observation in newly discovered societies—could there be such—given one or two leading facts as to their environment and the stage of civilization they had reached. We credit the science of geology with a power of prediction when the geologist in an Old Red-sandstone country is able to say positively that there is no use in prospecting there for coal. Why not allow the evolutionist equal credit if he is able to say beforehand of a given community that the mathematical faculty will be found to be very feebly developed in it, but that the poetic may be found to have made some advance; or if, taking two widely separated stages of a nation's history, he is able in a general way to fill in the intervening course of events, very much as Mendeleef describes a certain set of elements yet to be discovered?

When Mr. Spencer says, "With the repression of militant activities and decay of militant organizations will come amelioration of political institutions as of all other institutions," he makes a prediction founded on the general principles of his system—a prediction in which many who take their ideas from poetry and romance might not be disposed to concur. It remains to be seen whether the evolutionist is right, or whether those are right who hold that without war the higher civic and personal virtues would decline and wither. The difference between the two opinions is that the one is founded on a long course of study, and is correlated with a multitude of established facts; while the other is rather a matter of sentiment than of reasoned conviction.

We do not intend, however, to pursue further a controversy which was carried on to considerable length in the columns of the Times, and which developed so much of sympathy with, and so little of decided opposition to, Spencer as to cause the editor of that paper to exclaim, "Where are the foes of Spencer?" and to express his surprise at the backwardness of certain persons, who are supposed to regard the doctrine of evolution as false and dangerous in the extreme, in availing themselves of the opportunity of stating and defending their convictions. It remains but to say that the value of the synthetic philosophy is not bound up with the accuracy of every scientific or historical statement its author may have made, nor yet with the absolute solidity of his metaphysics. It is a great colligation of the laws of life and development. It teaches us to understand the world and human society, and gives to every one who studies it a superior power of discernment in many fields of observation. The evolutionist can predict in this sense

at least that, in a broad way, he knows what to expect, and does not look for grapes from thorns or figs from thistles. He sees cause and effect, action and reaction everywhere, not like some specialists in certain selected spheres exclusively. He believes in orderly progress, knowing that great processes of development can not be very materially hastened.

In the field of education the views derived from the general theory of evolution have been found of the very greatest value; and were education to-day free from the trammels of politics, and were it commanding—as, but for its connection with the state, it would command—the best thoughts and the best energies of a host of freely competing educators, the improvement in educational methods directly due to the new views would be most conspicuous.

The evolutionary philosophy is a practical one, and it is to-day on trial; its principles are more or less penetrating and permeating the community; and the more they do so, the more they are confirmed by experience, and become impressed on the mental habits of individuals. Of what competing philosophy can the same be said? It is to this growing experience of the race, therefore, that appeal must be made if the validity of the general theory is to be questioned.

LITERARY NOTICES.

THE EVOLUTION OF MAN AND CHRISTIANITY. By the Rev. HOWARD MACQUEARY. New York: D. Appleton & Co. Pp. 410.

THE assertion of Prof. Le Conte, which furnished the motive, as the author avers, for this book, that we are on the eve of the greatest change in traditional views that has taken place since the birth of Christianity—a change involving a reconstruction of Christian theology—is verified by events which have taken place during the current year in the official centers of the most orthodox Protestant bodies. The debate in the Congregational churches about future probation; the creed revision which has been resolved upon by the Northern Presbyterian Church; the provision by the English Presbyterian Church of a place for those who believe in the evolution and extreme antiquity of man; and the retention of Professors Dods and Bruce by the Free Church of Scotland after their persistent avowals of doctrines far more novel to the Calvinistic theology than those for which Prof. Robertson Smith was deposed seven years ago, are signs the meaning of which can not be mistaken. The right to criticise the Bible as any other book is criticised; to investigate phenomena regarded by the Church as supernatural in the same way that ordinary phenomena are examined; and to probe the foundations of Christian faith to the bottom, has asserted itself there and has commanded a hearing. Modern theology can hardly be blamed for the existence of errors which were ingrafted upon it during the ages of darkness and ignorance; but it ought to have been more prompt to recognize these errors and correct them, rather than by cherishing them till their absurdity was universally seen to have given temporary advantages to the enemies of Christianity. Professing, as it does, to seek the truth as science is doing, it should welcome every effort to make the truth more clear; and even mistaken searchings for truth are better than persistent adherence to what has been proved false. Science, the friend and devotee of truth, can never do more than establish and make more accessible to men the truth in religion; and it is behaving as the truest ally of religion when it throws the light of a better and more exact knowledge upon dogmas that were conceived by men when their sources of information were scanty and imperfect or did not exist.

The author of The Evolution of Man and Christianity is a clergyman of apparently good standing in the Protestant Episcopal Church. He goes further in the criticism and analysis of doctrine than any other author who has written from within the Church. He believes that a recasting of theological thought is necessary to meet the advance that has been made in physical science, which is destined profoundly to modify our idea of miracles; biblical criticism, which has cast new views on the origin and character of the sacred books; and the social

movement, which, assuming an anti-Church attitude, is leading the people into unbelief; and he here lays down the lines along which he thinks the revision should be made. The points of evolution and the antiquity of man have already been conceded by the best thinkers in the Church, but Mr. MacQueary has outrun them by applying evolution to the soul as well as to the body of man. The doctrine of the fall of man is rejected as irrational and contrary to the theory of evolution, yet our progenitor sinned, or freely violated moral, divine law, and transmitted to us an inheritance of corrupt habits; but Jesus, by what he taught, did, and suffered, has more than repaired the evil which resulted from Adam's transgression. The books of the Bible are believed to be works of slow growth, or collations made from documents or notes left by earlier writers; but "even the most radical skeptics admit that the books of the New Testament furnish us the essential facts of our Lord's life and teachings." The question as to the miracles is made one of evidence; the scientific man does not deny the possibility of anything. The author believes in prayer and Providence and in miracles, or that God has actually wrought extraordinary events. Some of the recorded miracles are treated as cases of faith-healing, some as invested with a poetical significance, and some as exaggerated versions of older traditions. The resurrection is believed to be spiritual and not of the earthly body, and the resurrection of Jesus and his forty days' sojourn with his disciples is interpreted as an investment with a spiritual body like that described in St. Paul's chapter on the resurrection. The miraculous birth of Jesus from a virgin, though its possibility is not denied, is regarded as "a poetic description of a great fact." The theory of verbal inspiration is treated as of heathen origin and as contradicted by the Bible itself; but insomuch as God has sent religious as well as philosophic and poetic geniuses into the world, who, though not absolutely infallible, are infallible so far as they discover and reveal truth, we have inspiration. The doctrine of the Trinity is traced back to extremely ancient times, and may be looked upon as a symbolic description of the manifold Infinite Spirit of God. The divinity of Christ is resolved into "the closest and most vital union of the Spirit of Jesus with the Divine Spirit from whom it sprung," so that "he was the divine under the limits of humanity." Instead of the Calvinistic doctrine of the atonement, which is exploded by evolution, showing its inconsistency with any true idea of God, we are shown Jesus saving his people from their sins, "first by setting them an example of perfect obedience to God's will, and then by assigning a motive to virtue strong enough to enable men to live soberly, righteously, and godly. That motive is the fatherly love of God toward man, which love was manifested in the mission and person of Jesus." Heaven and hell are believed to be spiritual conditions, not places; future punishment, though real, to be limited by the possibility of the ultimate recovery of the soul by infinite power, wisdom, and love. Immortality is accepted. The author's purpose has been, not to stir up bitter controversy, but to help those who are troubled by the difficulties of traditional and popular theology to a plane of thought where all will be made more clear to them; and he anticipates as the result of previous discussions an elevation and purification, a dematerialization and spiritualizing of our views on all the subjects involved.

While no one may be ready to accept all the author's conclusions as he states them, the book must be hailed as an earnest and honest attempt to reflect the light of science and modern research on the most difficult points of Christian doctrine, and to make the way more easy for their acceptance in their true sense. Whatever may be the fate of his particular views, his essay will tend to stimulate thought, and that in the direction of freeing religion from the excrescences which traditional superstition has fastened upon it.

THE PHYSICAL PROPERTIES OF GASES. By ARTHUR L. KIMBALL. Boston: Houghton, Mifflin & Co. Pp. 238. Price, $1.25.

REGARDING imitation as the most sincere praise, the International Scientific Series has received two very hearty indorsements lately, by the announcement of two series of scientific books, which follow its plan in part. One of these originates in England, and is also published in this country; the other is the Riverside Science Series, of which the

second volume is now before us. The publishers describe the latter series as a collection of books setting forth the achievements of scientific and mechanical skill at the present day. The volumes are intended to be as free as possible from technical terms, and to deal but little with matters of theory. Prof. Mendenhall's Century of Electricity, already issued, has been made the first volume of the series. Mr. Kimball's book is devoted to that department of physics usually known as pneumatics. It gives the properties of gases, and the current theories in regard to their constitution and behavior, in language that is readily understood and free from mathematics. A chapter is devoted to Geissler tubes and the phenomena of the radiant condition of matter as developed by Prof. Crookes. The text is illustrated with about forty cuts of apparatus.

THE UNKNOWN GOD; OR, INSPIRATION AMONG PRE-CHRISTIAN RACES. By C. LORING BRACE. New York: A. C. Armstrong & Son. Pp. 336. Price, $2.50.

THE author accepts the "modern method" of studying ethnic or heathen religions, by looking for what is good in them rather than searching for their defects or trying to show their inferiority to the highest—or his own—religion. He inquires how the man of other races and times regarded the problems of the universe; what was his conception of the primeval cause, how he considered his relation to it, and how far that relation affected his daily life and practical morals. In pursuing this study he expects to find with man in all ages and races some evidences of the inspiration of the Divine Spirit. Dealing first with the Hamitic and Semitic races, a period is found in Egypt in which a belief in the one God existed in the minds of the scholars and priests. Then, among the Semitic tribes of the valley of the Euphrates, the penitential psalms and prayers of the Accadians are stamped with a monotheistic spirit. Among the Aryan races the belief in God and a future judgment is discovered in the mysteries of the Greeks, and the faith in a spiritual God or Zeus is discerned in their early poetry, before the idea had been degraded by the myth-making fancy. "The evidence from the Greek dramatists and many of the ancient writers is here overwhelming that one spiritual God was at certain periods adored by considerable numbers of the Greek race." Similar evidences are found in the religion of Plato and Socrates, and of the Stoics. Monotheism and moral purity are found to be marked characteristics of the Persian religion of Zoroastrianism. The old Vedic hymns furnish the proof of Hindoo monotheism in the worship of Varuna, the heaven-god. The fullest descriptions are devoted to the Buddhist faith, which the author regards as "in a high degree inspired, and as an instrument in the hands of Providence for the elevation and purification of Asia." The final chapter is on the biblical argument for the inspiration of the heathen. The work is not designed for an attack on the heathen religions, or as a defense of Christianity; but rather to show what great truths have inspired the pious heathen of the past.

MIDNIGHT TALKS AT THE CLUB. Reported by AMOS K. FISKE. New York: Fords, Howard & Hulbert. Pp. 298. Price, $1.

THE "talks" which this little volume contains embody earnest and more or less conflicting opinions on some of the more serious subjects which are being discussed at the present time. It is not the purpose of the book to put forth judgments of startling novelty, and many readers will find in the utterances of one or another of the speakers represented simply their own views, though they may never have expressed them in the same way, or, in fact, at all, or perhaps were never quite conscious before that they held these views. The first subject discussed is temperance; from that the talk goes to the lack of practical work by the churches, and is led through the question of Sunday observance up to a discussion of religion in general. Political immorality is the subject of the next conversation, and the somewhat allied topic of the Irish Americans comes up for attention later. Most of the talks which follow concern religious matters, such as superstition and worship, the Scripture fetich, the teachings of Moses and the prophets, and the usefulness of religious delusion. Other fields are entered in discussions of the value of human evidence and the power of personality. Throughout the volume the modern progressive views are

the ones most fully presented, and the tone of the book is against submission to prejudices, and favors the recognition of whatever good there is in every institution, opinion, or person.

STUDIES IN HEGEL'S PHILOSOPHY OF RELIGION. With a Chapter on Christian Unity in America. By J. MACBRIDE STERRETT, D. D. New York: D. Appleton & Co. Pp. 348. Price, $2.

HEGEL, the author says, is recognized as a thinker whose comprehension of thought and its method no student of philosophy can fail to acknowledge as great among the greatest. He was radically and throughout a theologian. All his thought began, continued, and ended in that of divinity. He tried in his Philosophy of Religion to satisfy man's demand to know what there is in religion; to discover and state its speculative idea. "But with him the speculative was both vital and practical—the very life of the spirit throbbing through all the tangled mass of varied religious phenomena in the world's history." His whole logic is interpreted as being but "his explication of the nature and activities of God immanent in the actuality and order of the world, and transcendent as its efficient and final cause." Agnosticism, both atheistic and Christian, is repudiated throughout. "God knowable because self-manifesting, and man in duty bound to study this knowledge, are with Hegel self-evident and demonstrable principles." While he is regarded as a pantheist, in the Christian sense, his doctrine of God is the Christian and not the deistic or pantheistic doctrine. "In him all finite beings find, not lose, their reality." Hegel's philosophy at his death had pervaded universities, state, and church, and for ten years afterward remained the foremost intellectual phenomenon of the time. But the interpreters of his system, each seeking in it his own dogma, and finding it, have succeeded in dismembering it into parts whose various aspects have seemed to various types of mind to be the whole system. While in Germany it has almost ceased to exist as a professed system, its spirit and method have become inextricably entangled with the whole thought and culture of the country, and are the leaven at work in its current philosophy. In Great Britain it has also greatly influenced philosophic thought, though accepted and expounded as a system by none. In England and America the interest in Hegel is chiefly owing to the relation of his thought to religion and to Christianity. His thought attracts Christian thinkers seeking for intellectual comprehension of religious experience, faith, and facts. They are drawn to him "because they find him thinking weightily on the same" subjects; and yet the chief opposition to the study of Hegel "comes from the *odium theologicum* of Christian teachers." But the students of the Hegelian philosophy disclaim being what the term Hegelian, either in the popular or scientific sense, would imply, for they are mastering and using his method, rather than accepting all the results which that method yielded to him. In Dr. W. T. Harris's opinion, no other work better deserves translation into English than the Philosophy of Religion. But any real translation of it would be inadequate, and would need a further translation into expository paraphrase. Dr. Sterrett, therefore, instead of a translation, offers "studies" of his system. The purpose of the volume throughout is apologetic. "It is written with faith and in the interest of 'the faith,' though demanding an almost antipodal orientation or point of view to that of both deistic orthodoxy and ecclesiasticism." Pertinently to the latter feature of his course, the author well says that "it is mere time-serving to manufacture evidences when there are none. It is as useless as it is wrong to attempt the 'hard-church' method of overriding reason and conscience with the mere weight of an uncriticised authority. It is both anti-theistic and anti-Christian to profane the secular in the interest of the sacred."

ORGANIC EVOLUTION AS THE RESULT OF THE INHERITANCE OF ACQUIRED CHARACTERS ACCORDING TO THE LAWS OF ORGANIC GROWTH. By Dr. G. H. THEODOR EIMER. Translated by J. T. CUNNINGHAM. London and New York: Macmillan & Co. Pp. 425. Price, $3.25.

THE translator of this work explains, as his reason for presenting it to the English-reading public, that he had become dissatisfied with the "uncritical acceptance" accorded to Prof. Weismann's theories of heredity and variation by many English evolutionists. He was inclined to attach more

importance to the causes of variation than to any of the other problems considered by Darwin, among which functional activity and external conditions seemed the most powerful. He was thus led to believe that a deeper insight into the phenomena of evolution would ultimately be obtained by pursuing the line of inquiry suggested by Lamarck; than by continually searching for new instances of adaptation to be explained by the Darwinian formula. While in this frame of mind he was "delighted to find" that Weismann had to contend with a formidable opponent in his own country, and concluded that he could not for the present oppose the progress of his views more effectively in England than by publishing a translation of Prof. Eimer's arguments. It had seemed to this author long ago to be of the greatest importance to undertake an investigation of the question whether the modification or variation of the species of animals is not governed by definite laws. The Darwinian theory suggested none. The investigation of the laws of variation included the question of the causes of variation. There was likewise a gap in the Darwinian theory where these should be explained. The principle of utility, the selection of the useful in the struggle for existence, did not explain the first origin of new characters, but only, and that partially, the progress and the gradually effected pre-eminence of those characters. If we could know, the author assumed, all the natural laws which have operated in the evolution, and which operate in the existence of a single animal or a single plant, we should understand the laws of the organic world altogether. Applying this principle, the unreserved study of a single species of animal, the author declares, led him to the discovery of a whole series of laws, which the extension of the investigation to other species showed to hold good generally. This animal was the wall-lizard (*Lacerta muralis cærulea*), a species of remarkable variability, with which he became acquainted on the rocks of Capri. The result of his researches, which were extended to various classes of animals, "was the recognition of the dominion of laws in the process of variation, not only of the lizard, but also in the most diverse tribes of the animal kingdom; these laws holding firstly in the variations of marking, previously regarded as quite indifferent, unimportant, or fortuitous, but also applying to other characters. I was able to demonstrate that variation everywhere takes place in quite definite directions which are few in number, and I was able on the basis of my observations to put forward the view that the causes which lead to the formation of new characters in organisms, and in the last result to their evolution, consist essentially in the chemico-physiological interaction between the material composition of the body and external influences. Finally, I succeeded, through the facts I established, in referring the separation into species, . . . in connection with the rest of my views, to natural causes." Previously to presenting these results in the present volume, a brief review is given of the newest theories concerning evolution. The translator has endeavored to make his work sufficiently English to be readable, and to preserve the full force and exact significance of Prof. Eimer's expression.

A Short Course of Experiments in Physical Measurement. By Harold Whiting. In Four Parts. Part I: Density, Heat, Light, and Sound. Cambridge: John Wilson & Son. Pp. 278.

The course of laboratory work which this book is to comprise covers the ground of both the "minimum" and the "maximum" requirements in physics for admission to Harvard College, and it is intended also to serve as a preparation for courses in mechanical and electrical engineering in other institutions. Mental training is the chief object aimed at, through the care required, and the practice in inductive and controlled methods secured. The policy of the book is rather "to show how comparatively accurate results may be obtained by rough apparatus, than to explain the use of instruments of precision, which in the hands of a student are apt to give erroneous results." The author states that not so much mathematics is involved in these experiments as would appear from a first glance, because many proofs are given in full here which in most text-books have been taken for granted. The volume is illustrated with many cuts of apparatus. The second, third, and fourth parts are to contain experiments in other departments of physics.

LABORATORY MANUAL OF EXPERIMENTAL PHYSICS. By ALBERT L. AREY, C. E. Syracuse: C. W. Bardeen. Pp. 200. Price, 75 cents.

NEGLECT of experimental science-teaching will not be much longer excusable for lack of suitable laboratory manuals. Mr. Arey's book consists of brief directions for seventy experiments in the several departments of physics, with suggestive questions as to what is shown by each experiment. The right-hand pages are left blank, or contain forms for entering the results of observations. The experiments are adapted to pupils in secondary schools, and are characterized by involving measurements, the author being convinced that "vastly greater mental discipline will be derived by the student from quantitative experiment" than from qualitative. It has been a part of the author's plan, also, to devise inexpensive apparatus with which results may be obtained sufficiently accurate to point conclusively to the law under consideration. Directions for making many pieces of this apparatus are appended to the book. The text is illustrated with fifty-six figures.

THE CHEMISTRY OF PAINTS AND PAINTING. By A. H. CHURCH, F. R. S. London: Seeley & Co., Limited. Pp. 310. Price, $1.75.

ARTISTS are supplied in this volume with a great deal of practical knowledge concerning the chief chemical and physical characters of the materials and processes that they use. There are other books that treat of the pigments employed, but this deals also with painting-grounds (paper, plaster, stone, wood, and canvas), with vehicles and varnishes, and with methods and results. In describing the materials which artists use, the sources from which they are obtained are told, and in many cases the mode of preparing them is given. Tests for purity and genuineness, that take but little time or apparatus, have also been inserted. Chapters that will contribute to the durability of the artist's work are those on the permanency of pigments, and the conservation of pictures and drawings. Exact knowledge in regard to permanency is furnished in the chapter containing results of trials by Mr. F. W. Andrew, Prof. Rood, Prof. Hartley, and by Dr. Russell and Captain Abney, as reported to the South Kensington Museum. The volume is adequately indexed, and its mechanical work is excellent.

THE TRUE GRASSES. By EDUARD HACKEL. Translated from Die natürlichen Pflanzenfamilien, by F. L. SCRIBNER and EFFIE A. SOUTHWORTH. New York: Henry Holt & Co. Pp. 228.

PROF. HACKEL'S monograph on the grasses, here translated, was contributed to the great German work on the Natural Families of Plants, edited by Drs. Engler and Prantl. The book consists of a botanical key to the *Gramineæ*, through which are interspersed full descriptions and cuts of the economically important species. The grass family includes a large number of plants which are of great value as furnishing food for man and for his domestic animals, as well as supplying a great variety of products used in the arts and in medicine. Among these are Indian corn, sugar-cane, bamboo, the grains, and the fodder grasses. The opening chapter gives an account of the general structure, morphology, and physiology of the *Gramineæ*. The translators have added an introduction, giving an example of how a botanical key is used, a full glossary, and an index, in order to make the volume more useful as a text-book in agricultural colleges. The illustrations number over a hundred.

EVOLUTION, ANTIQUITY OF MAN, BACTERIA, etc. By WILLIAM DURHAM, F. R. S. E. Edinburgh: Adam & Charles Black. Pp. 127. Price, 50 cents.

THE Messrs. Black issue this little volume as the first of a series under the general title Science in Plain Language, the design of which is to impart the general results of scientific investigation in common language, and without a great deal of detail. The book consists of about twenty short articles grouped under four heads. Those in the first group deal with evolution and primeval man, those in the second are devoted to the lowest living organisms, the third contains papers on color in plants and animals, and in the fourth various movements in plants are described. Each essay is complete in itself, yet their subjects are so selected that they are all connected, and all unite to form a general picture of the evolution and general phenomena of life.

A Bibliography of the more Important Contributions to American Economic Entomology has been prepared by *Samuel Henshaw* for the Department of Agriculture. Parts I, II, and III, already issued in one volume, contain the more important writings of Benjamin D. Walsh and Charles V. Riley. Those by B. D. Walsh number 385 titles, those by Walsh and Riley jointly are 478, while the writings of Prof. Riley alone number 1,555. A general index to the list and indexes of new names proposed are appended to the volume.

The seventh edition of *Bloxam's Chemistry* (Blakiston, $4.50) follows the sixth after an interval of only two years. It has been revised and edited by Prof. *John M. Thomson* and *Arthur G. Bloxam*, who give the following statement in the preface as to the changes they have made: "In the Organic division of the book an attempt has been made to give concise accounts of more modern research—such as Raoult's method for the determination of molecular formulæ, and Fischer and Tafel's investigations on the synthesis of sugars. In the same division the Chemistry of Vegetation has been in a great measure rewritten to suit more modern views. Those portions of the book relating to Explosives, to which the work to some extent owes its reputation, have been revised, and are treated of as fully as possible within the limits of a general textbook." The volume has been increased in length about ten pages.

A second edition of *The Microtomist's Vade-mecum*, by *Arthur B. Lee*, has been issued (Blakiston). It is much larger than the original English edition, and in fact is not based upon that, but upon the French work with a different title, by Lee and Henneguy, published two years later. Besides including the important advances made in its field since 1885, the present Vade-mecum differs from the first in being much less historical and much more critical. The subjects of most importance in a technical manual have been treated more fully, and those which are less important, or whose best place is elsewhere, have been thrown into the background. Among the chapters that have been extended are those on fixing, impregnation methods, paraffin and celloidin imbedding, and the special methods of embryology, of cytology, and of neurology. The volume has an index, and its paper and print are excellent.

A Clinical Study of the Skull—the tenth of the Toner Lectures—by Dr. *Harrison Allen*, is a contribution to the morphological study of diseased action. The materials on which it is based were found in the Collections of the Academy of Natural Sciences of Philadelphia and of the College of Physicians, Philadelphia, which together contain more than nineteen hundred specimens of skulls. Washington: Smithsonian Institution.

The March Bulletin of the Connecticut Agricultural Experiment Station is a paper on *Fungicides*, or applications for such diseases as the black rot and the mildew of the grape, by *Roland Thaxter*. The applications recommended are Bordeaux mixture—sulphate of copper and quicklime, with water—and ammoniacal carbonate of copper; which are sprayed over the plants. The treatment is most effectual when it is applied preventively.

The second year's work of the Agricultural Experiment Station of the University of Illinois, ending July 1, 1889, comprised analyses of fodders and of various food products, with numerous items of new work taken up from time to time. Four bulletins were issued, reporting experiments upon oats, upon corn, experiments with ensilage, and experiments of the effects upon the hay of cutting certain grasses and clovers at different periods of growth. Bulletin No. 7, November, 1889, is upon the Biology of Ensilage; and Bulletin No. 8, February, 1890, records a series of field experiments with corn.

The work of the Massachusetts State Agricultural Experiment Station, as presented in its report of 1889, was carried on in the same principal lines of investigation as in preceding years. A very important part of it is represented in the investigations of fungoid diseases by Prof. Humphry. To the experiments for determining the cost of feed for the production of beef and pork were added similar ones respecting beef and mutton. Laboratory work was especially large, and extended in various directions.

References to the Constitution of the United States, which has been prepared by

William E. Foster for the Society for Political Education, might be described as a bibliography. The references are historical—to the antecedent influences, the framing and adoption of the Constitution, and Constitutional History since 1789—and cite numerous papers and books on each branch of the subject. In the Appendix are given the constitutional interpretations since the civil war affecting the question of national or State supremacy.

Letters from Waldegrave Cottage, by the Rev. *George W. Nichols*, is a collection of reminiscences, portrayals of eminent or lovable men, and rural sketches, which, published first in a monthly magazine, are gathered up into a single volume. The author claims descent from the Earl of Waldegrave, and is able to point to the graves of ancestors among the venerable tombs of Trinity and St. Paul's churches, New York. The essays include sketches of life, scenes, and persons at various places in Connecticut and Massachusetts, Yale College, Brooklyn, N. Y., etc., notices of famous divines and men eminent in the life of society and the State, and other items of personal reminiscence such as usually furnish pleasant reading even to strangers; and there is an air of repose about the whole that is refreshing to the reader vexed with the controversies of the day. (Exchange Printing Company, New York.)

The historical novels published by W. S. Gottsberger form an attractive-looking department in the library, and the promise offered by their neat exteriors is usually more than fulfilled when they are read. They include pictures of Oriental antiquity, the classical period, the middle ages, and heroic or romantic episodes of later times, sketched by the master artists in their respective fields. Among the latest of these publications is *Nero*, by the German *Ernst Eckstein*, one of the most famous and most prolific of the writers of this class. Its special effort is to describe how Nero, from the gentle and noble character he is said to have been by nature, became transformed into the inhuman monster of whom such incredible tales are told. This purpose leads to the more comprehensive treatment of the separate stages of development rather than the excesses of the matured criminal.—In *Joshua*, Dr. *Georg Ebers* has attempted to treat the wanderings of the Israelites during and after the Exodus in the form of a romance. In it he has made use of his own observations in the field covered by the wanderings, and of the latest results of archæological explorations in the Nile Delta; and in the "scenery of the drama" he has copied as faithfully as possible from the landscapes he beheld in Goshen and on the Sinai Peninsula. For the incidents he has relied on the Bible and Egyptian records.—*Ekkehard*, a Tale of the Tenth Century, has been written by Herr *Joseph Victor von Scheffel*, in the belief that a union of history and poetry, for working purposes, would be detrimental to neither. The materials from which it is composed are derived from the tales of the monastery of St. Gall, begun by the monk Ratpert, and continued to the end of the tenth century by Ekkehard the Younger, contained in the folios of the Monumenta Germanica, which are described as being, in spite of much *naïveté* and awkwardness, "charming stories, made up of traditions of older comrades, and accounts of eye and ear witnesses." Quite unconsciously, the author adds, "these annals carry us far beyond the boundaries of the cloister walls, presenting the life and aims, the culture and customs of the Alemannia of that period with all the fidelity of a picture painted from nature."

The Truth-seeker Company publishes a symposium on the question of the *Existence of a Positive, Constructive Side to Free Thought*, to which some twenty of the most prominent representatives of the school described as freethinkers are contributors. Besides the direct question, the character and scope of the constructive side are considered by those who answer affirmatively, or the reason why there is no such side if the answer is negative.

In his paper on *Etruscan and Libyan Names; a Comparative Study*, Dr. *D. G. Brinton* seeks evidence of affinity between the race of which the Berber tribes of the present are the representatives and the ancient Etruscans. In a former paper (October, 1889) he supported his theory by comparison of physical traits, customs, arts, and language; in the present one he carries out, to a limited extent, a comparison between

the proper names preserved in the oldest Libyan monuments and a series of similar names believed to be genuine Etruscan.

In its third edition, the *Directory of Writers for the Literary Press*, compiled by *W. M. Griswold* (the author, Bangor, Me., $1), has been expanded to fifty-nine pages. It gives the full names of writers, their addresses, professional positions, date of birth, and subjects on which they write. The addresses of the chief American and English periodicals, literary clubs, and colleges are also included in the directory. A list of authors recently dead is appended.

A number of special papers by Dr. *Edgar A. Mearns* on the natural history of the Western Territories and other localities testify to his industry and carefulness in that study. *Description of Supposed New Species and Subspecies from Arizona* gives ten species and some subspecies of rodents (a squirrel, a musk-rat, mice, hares, etc.), with detailed measurements and characteristics. A paper on *Arizona Mountain Birds* furnishes illustrations of a feature which the author desires to emphasize, of the extension of the Alpine flora and fauna of the Rocky Mountains southward into this Territory, where they appear on the mountains, with characters changing according to the altitude, "like islands in a region of more southern aspect." Other papers include a list of the *Birds of Fort Klamath, Oregon*, collected by Lieutenant Willis Wittich, annotated and added to; and an *Addendum* to a list of the *Birds of the Hudson Highlands*, with annotations. A welcome feature of these papers is that good English names are given for all the species. Two other papers, relative to Dr. Mearns's work, are published by the Herbarium of Columbia College. They are a list of the plants collected by him at Fort Verde and in Mogollon and San Francisco Mountains, by N. L. Britten; and the General Floral Characters of those regions, by H. H. Rusby.

In a *Tube-building Spider*, Mr. *W. L. Poteat*, of Wake Forest College, N. C., publishes some interesting notes on the architectural and feeding habits of *Atypus niger*. In asserting that "quite unaccountably American naturalists have taken comparatively little interest in spiders," the author seems to overlook the voluminous contributions of McCook, which have been acknowledged to be among the most valuable that have been made; the more modest but very intelligent and original researches of the Peckhams; and the work of other authors whose papers have come to us from time to time—all showing that the subject has not been neglected.

PUBLICATIONS RECEIVED.

Agriculture, United States Department of. Treatment of Plant Diseases. Pp. 23.

Bainton, George. The Art of Authorship. New York: D. Appleton & Co. Pp. 355. $1.25.

Barus, Carl. Thermo-Electric Measurement of High Temperatures. Washington: U. S. Geological Survey. Pp. 813.

Boston Society of Natural History. Correspondence relating to the Nampa Image. Pp. 36.

Clarke, F. W. Work done in the Division of Chemistry and Physics, 1886-'87. Washington: U. S. Geological Survey.

Dawson, G. M. Larger Unexplored Regions of Canada. Pp. 12, with Map.

De Guimps, Roger. Pestalozzi, his Life and Work. New York: D. Appleton & Co. Pp. 438. $1.25.

Dodel, Arthur. Instruction in Drawing. Boston: The Prang Educational Company. Pp. 34.

Fontaine, W. S. Potomac, or Youngest Mesozoic Flora. Washington: U. S. Geological Survey. Two volumes. Pp. 377, and 180 Plates.

Foster, Michael, and others, Editors. The Journal of Physiology. Vol. XI, No. 3. Cambridge, England. Pp. 104, with Plates. $5 a volume.

Frazer, Persifor. The Philadelphia Meeting of the International Congress of Geologists. Pp. 10.

Frédericq, Paul. Study of History in Germany and France. Baltimore: Johns Hopkins University. Pp. 118. $1.

Fullerton, G. S. Sameness and Identity. Philadelphia: University of Pennsylvania. Pp. 156.

Gardener, Helen H. A Thoughtless Yes. New York: Belford Company. Pp. 231.

Geddes, Prof. Patrick, and Thomson, J. Arthur. The Evolution of Sex. New York: Scribner & Welford. Pp. 332. $1.25.

Gunton, George. Evolution of the Wages System. Boston: J. H. West. Pp. 16. 10 cents.

Halsted, Byron D., New Brunswick, N. J. Rusts, Smuts, Ergots, and Rots. Pp. 19, with Plates.—Stamens of Solanaceæ. Pp. 4, with Plates.

Hay, Robert. Geological Reconnaissance in Southwestern Kansas. Washington: U. S. Geological Survey. Pp. 48, with Map.

Heath, D. C., & Co. Catalogues of Publications and of Modern Language Texts, 1890. Pp. 150 and 58.

Hensoldt, Dr. H., New York. Crystallogenesis. Pp. 16.

Heydenfeldt, S., Jr. The Unison of the Conscious Force. San Francisco: W. Huston & Co. Pp. 30.

Iowa College, Grinnell, Catalogue, 1889. Pp. 60.

Kimball, John C. Evolution of Arms and Armor. Boston: J. H. West. Pp. 32. 10 cents.

Kirk, Edward C., Philadelphia. The Manual Training Idea in Dental Education. Pp. 26.

Knowlton, F. H. Fossil Wood and Lignite in the Potomac Formation. Washington: U. S. Geological Survey. Pp. 52, with Plates.

Ladies' Health Protective Association of New York. Report for 1888 and 1889. Pp. 23.

Lewis, T. H., St. Paul, Minn. Effigy Mound in Iowa. Pp. 8.

Linnæan Society, New York. Abstract of Proceedings for 1889–'90. Pp. 20.

Little, William. Letter on Timber. Montreal: John Lovell & Son. Pp. 42.

Mack, C. S., M. D. Philosophy in Homœopathy. Chicago: Gross & Delbridge. Pp. 174.

MacQueary, Rev. Howard. Evolution of Man and Christianity. New York: D. Appleton & Co. Pp. 410. $1.75

Mantegazza, Paolo. Physiognomy and Expression. New York: Scribner & Welford. Pp. 327. $1.25.

Mercier, Charles. Sanity and Insanity. New York: Scribner & Welford. Pp. 395. $1.25.

Minnesota, University of. Catalogue for 1889–'90, etc. Pp. 143.

Montillot, Louis. L'Amateur d'Insects (The Amateur of Insects). Paris: Baillière. Pp. 302.

Newberry, J. S. Paleozoic Fishes of North America. Washington: U. S. Geological Survey. Pp. 226, with Fifty-three Plates.

New York State Board of Charities. Twenty-seventh Annual Report. Pp. 411.—Report on the Care of Dependent Children. Pp. 77.

Ontario, Report of Royal Commission on Mineral Resources. Toronto: Warwick & Sons. Pp. 506, with Map.

Ott, Isaac, M. D. Malarial Fever. Pp. 64.

Owen, Edmund. Manual of Anatomy. New York: Longmans, Green & Co. Pp. 526. $3.50.

Powell, J. W., Director. Report of United States Geological Survey, 1886–'87. Two volumes. Pp. 1,060, with Plates.

Remsen, Ira, Editor. American Chemical Journal, June, 1890. Baltimore. Pp. 76. 50 cents. $4 per volume.

Ryder, John A. Origin of Sex, etc. Pp. 50.

Savage, M. J. The Jericho Road. Pp. 17.—Answer to a Letter. Pp. 16.—The Many-windowed House of Life. Pp. 14. Boston: G. H. Ellis. 5 cents each.

Skilton, James A. Evolution of the Mechanic Arts. Boston: J. H. West. Pp. 24. 10 cents.

Smith, Alexander. Dreamthorpe. Rochester, N. Y.: George E. Humphrey. Pp. 332. $1.25.

Spencer, Prof. J. W. Iroquois Beach (Lake Ontario). Pp. 14.—Ancient Shore Phenomena near the Great Lakes. Pp. 24.

Stevens, W. Le Conte. Microscope Magnification. Pp. 12.

Sullivan, J. W. Ideal Kleptomania. New York: Twentieth Century Publishing Company.

Sutton, J. Bland. Evolution and Disease. New York: Scribner & Welford. Pp. 285. $1.25.

Thayer, E. H. The Mortgage Foreclosed. Chicago: Belford-Clarke Company. Pp. 282.

Thornton, John. Advanced Physiography. New York: Longmans, Green & Co. Pp. 342. $1.40.

Thurston, Robert H. Heat as a Form of Energy. Boston and New York: Houghton, Mifflin & Co. Pp. 261. $1.25.

Unwin, W. Cawthorne. Elements of Machine Design. London and New York: Longmans, Green & Co. Pp. 450. $2.

Wahl, W. H., Philadelphia. Electro-Deposition of Platinum. Pp. 14.

Wentworth, G. A. A School Algebra. Boston: Ginn & Co. Pp. 362.

Wheelbarrow. Articles and Discussions on the Labor Question. Chicago: Open Court Publishing Company. Pp. 303. $1.

Woodward, Prof. C. M. The Educational Value of Manual Training. Boston, etc.: D. C. Heath & Co. Pp. 95.

POPULAR MISCELLANY.

Instruction by Experimental Methods.—As represented by Prof. J. F. Woodhull to the American Institute of Instruction, the New York College for the Training of Teachers has model classes of pupils in all grades to which apprentice teachers are assigned at stated hours to give experimental instruction in science. In the primary and grammar grades the experiments are performed by the teachers in presence of the pupils, after which the pupils are questioned concerning what they have observed. They are also allowed to examine the objects closely in hand. Familiar, every-day objects, which are convenient for manipulation are used. The purpose is not to load the children with facts, but to arouse their curiosity and beget in them inquiring habits of mind. In the high-school department, systematic scientific instruction is begun for the purpose of developing careful habits of experimenting, observing, and reasoning. Familiar objects or home-made apparatus are preferred for the experiments, both because most of the high schools are not in a position to purchase elaborate apparatus, and because they are believed to be more fit for the purpose. The apparatus in the markets is considered insufficient, "because most pupils of high-school age fail to comprehend the machines, and their minds are confused by them with reference to the principles." The pupils are taught to construct their own apparatus so far as there seems to be educational value in that kind of work; and in most cases such constructions have fulfilled their purpose better than the conventional apparatus. They are not intended to illustrate the apparatus of the markets, or to serve as a cheap substitute for it, but to illustrate scientific principles, for which imitations of "show-case" apparatus are not required. Of course, no attempt is made in this system to teach the whole of science or to cram with facts; but "to show the pupil how to study nature so that through life he may go on to acquire knowledge." Mr. Woodhull's conclusion is that "patience and a love for the work are the most essential qualifications for the teacher; with these and with freedom from unnecessary restraints, however meager other equipments may be, science may readily be

taught in the common schools by experimental methods." The American Institute of Instruction substantially approved Mr. Woodhull's position, and resolved that instruction by experimental methods should be given in schools of all grades; in the primary and grammar grades it should take the form of observation lessons calculated to develop the spirit of investigation; and in the high school "it should undertake to give a thorough training in scientific methods of studying nature rather than a comprehensive knowledge of the whole realm of natural science."

Mounds of the Mississippi Basin.—The mounds of the Mississippi basin are described by Mr. T. H. Lewis, of St. Paul, as being of a magnitude and extent calculated to surprise those who have not examined them. There are thousands of them in Mississippi and Arkansas, and probably thousands in Minnesota. The author's own personal surveys in Minnesota now exceed one thousand, and the localities of at least as many more are known. The mounds in Mississippi—in the bottom-lands—are burial-mounds, and in addition to human remains usually contain earthen vessels and pipes of all sizes and shapes, with occasionally flint and stone implements and articles of copper. The clay mounds of Arkansas and of the bluffs along the Mississippi seldom contain any implements or pottery. Temple mounds are always associated with mounds of other forms, and are never isolated. They have approaches or graded roadways built to the summit, and generally have aprons or terraces on their sides. Smaller mounds having the same forms were used for burial purposes. Platform mounds are another class of temple mounds, and have from one to four approaches. Some of them are also known to contain human remains. Of a class of mounds called hearth mounds the purpose is difficult to determine. They hardly ever reach four feet in height, and the hearth is covered with earth from three inches to two feet in depth. The hearths vary in thickness from one and a half to thirteen inches. The low flat mounds of Minnesota and Dakota are often regarded as the remains of dwelling-houses of the aborigines. The theory is that poles were set up and sods were afterward placed upon the outside; and that the poles having rotted away, the structure fell to the center, and in the course of a few years the top became leveled by the accumulation of dust and vegetation, so that a mound was formed. The Indians used the mode of structure described; but it could hardly have been applied in these mounds, for such a structure, having once fallen, would have become an irregular mass with a concave top, and an opening on the side where the entrance had been — presenting a different appearance from the mounds. None of the mounds of Minnesota, in the author's opinion, were suitable for use as the base of *pueblos;* and he finds no evidence that the large flat mounds of the lower valley were of that character.

The Australasian Scientific Association.—The Australasian Association for the Advancement of Science met in Melbourne early in January. Baron von Mueller was president. The roll of membership included a thousand names, and more than six hundred were in actual attendance. The president's address dealt with the past and future of Australasian science; and the addresses of the presidents of sections were in many cases on subjects of particular interest in Australia. The most important of the committee reports was that on the census of the known minerals of the Australian colonies. A project for establishing and endowing a central biological station at Port Jackson was started. A report was presented on the Polynesian races and Polynesian bibliography. New special committees were appointed to investigate and report on the subjects of wheat-rust; the manner of laying out towns; the preparation of geological maps; the arrangement of museums; the fertilization of figs; Australian tides; and the present state of knowledge of Australasian paleontology. The next meeting is to be held in Christ-church, New Zealand, with Sir James Hector as president and Prof. Hutton as secretary; and the next in Hobart, Tasmania.

An Arizona Squirrel.—A rare squirrel, new to the Territory of Arizona, is described by Mr. Edgar A. Mearns as the round-tailed spermophile (*Spermophilus tereticaudus*, Baird). It is the most abundant and

characteristic mammal of the torrid, sandy, desert region south of the Gila River, where it lives in immense colonies in chambers excavated under the greasewood-roots. Such sites seem to be selected for the sake of the support afforded by the fine roots of the greasewood for the domes of their habitations. Without some such support the light and loose soil would cave in at once. Large, low mounds are formed over the burrows in which many holes are provided for ingress and egress. In some parts of Arizona these mounds are frequently seen in open, grassy places, and are usually large and high. The animals are shy; they sit up erect at the entrance of their burrows, like prairie-dogs, and like them dodge in at the sight of a stranger. When surprised away from home they try to skulk unobserved to their holes, nervously glancing at the observer. But they become less shy when accustomed to the neighborhood of man. Mr. Mearns adds to his description in curiously learned language which becomes expressive when translated, that "although eminently fossorial, this animal is endowed with latent scansorial proclivities, which are brought out by the sight of food in elevated situations. In other words, they will climb for mesquite-beans."

The Circle of Civic Evolution.—The modern, civilized state is developed, in Mr. John A. Taylor's view, as expressed in his address on its Evolution, from the germ that lay dormant in the rude elements of government that existed in the past—as the Cologne Cathedral, completed only a few years since, has been built in exact fulfillment of the conception of its unknown architect, six hundred years ago. Our American commonwealth, based on the idea of government by the governed, expressed at its birth the highest type to which the state had then evolved. This evolution, from all the attempts at government in the past, has been inseparably accompanied and verified by the continual uplifting and expansion of manhood as a type. Now we find that evils have been developed within our system which threaten its existence, and appear to be dragging down "manhood as a type": they are most conspicuously manifested in the cities, but exist through the whole political body. They are very numerous, but may be generalized under the terms corruption and bossism. Public interests are made an affair of trade, and are openly used for private advantage; and no measure, however important and beneficial, can be secured unless it can be made profitable to the ring of practical politicians. Everything has fallen into the hands of the leaders of the great political parties, who manage the parties and the community alike at their will, while the people appear to look on helpless. If the people are competent to govern, as our Constitution supposes, why do they not right matters? Mr. Taylor's answer to this question is not wholly confident; but he suggests that the rapid advance we have gone through in wealth and invention, with our constantly changing environments, have engendered problems of which the framers of our Constitution never dreamed; and that, having delegated our right of choice to the politicians, we have reached an epoch in the evolution of the state when the art and science of government are left in abeyance, and the best thought and effort of our time are given to other pursuits. Yet he has hope for our government, and offers the suggestion that "at some time, perhaps in the far-distant future, the state will have evolved into an entity of purely delegated as distinguished from representative powers"—which will look much like a return to monarchy and lords.

Judge-made Law.—Mr. Rufus Sheldon, in his paper on the Evolution of Law, argues that so much of the law as is defined by the decisions of the courts is made by judges. "That judges make law," he says, "is not explicitly stated in the text-books. In fact, it is not generally admitted that they have any part in law-making; the theory being that there is somewhere a store of ready-made law, consisting of rules and precedents, where the judges somehow find what they want after the lawyers have searched for it in vain, and then expound and apply it with plenty of comment and *obiter dicta*, but no addition." But it often occurs that, if any determination of right or liability is made, it must be made by the court; as must happen in every instance where judgment is given in a case different from any to be found in the reports—and just in proportion

to the difference of the circumstances from those of any previous case is the amount of new law made. So the law increases, following civilization as it advances, till at last the total becomes an enormous bulk of judge-made laws; the result of the progressive deduction of rules and principles by a process of distinguishing by small variation, variations from previous cases similar, but not identical; so that, when a decision is made, some increment is added to the body of the law, or substitution of new for old is made, even to such a degree that at last, by the slow process of disintegration, the old law is reversed. "A distinctive characteristic of legislation is that it is supreme over all other methods of law-making. Its advantage is that it can make the will of the people effective much more directly and expeditiously than the other agencies. Many are the cases in which legislation has swept away the cobwebs of legal subtlety, simplified technical laws, and cleared from the path of progress the obstacles of precedent and form."

Tests and Characteristics of Rabies.—Rabies, says Dr. Armand Ruffer, is a specific infectious disease, the first origin of which is unknown. But we know that nowadays it never occurs spontaneously, and that, wherever it appears, it may be traced to the bite of a rabid animal or the accidental introduction of rabic virus through a scratch or cut. Climate seems to have no influence, or very little, on its production. That heat has little to do with it is shown by the fact that it occurs in cold as well as in hot climates. In temperate climates, cases occurring among dogs appear to be as common in winter as in summer. Cruelty may also be excluded as a cause of rabies. Dogs may be teased and provoked to bite in anger, but, though mad dogs, they are not rabid dogs. The chief propagator of the disease is the dog; but he does not always, at first, exhibit the symptoms regarded as characteristic of it. He is not usually afraid of water, and the first symptoms, instead of signs of fury, usually simulate an increase of affectionate sentiments. Even at this stage, however, the saliva already contains the virus, and is dangerous. Later on, the victim becomes sullen and morose, with a very characteristic bark, biting every dog he comes across, and frequently runs away, snapping at animals or men as he meets them, till he dies exhausted, perhaps sixty or seventy miles from home. The dumb variety of rabies, which is characterized by the symptoms of paralysis, is equally common and dangerous with the furious form. The virus is the same, but gives rise to different symptoms. Rabies is also propagated by wolves where they are numerous; and it may be met with in foxes, horses, sheep, and cattle which have been bitten by rabid animals, but is seldom communicated from them. The cat is dangerous, but not so dangerous as the dog, because her disposition is to seclude herself. Some erroneous notions prevail as to the manifestations of the disease in man. As a matter of fact, in many cases the patient is calm and conscious, and attacks of excitement are rare. The foaming at the mouth is caused by inability to swallow the saliva. The changed voice is a result of dryness and spasms of the throat. A patient may occasionally bite the attendants during a paroxysmal attack of fury, but in the majority of cases he does not try to injure those near him, and hardly ever tries to bite. Sometimes there are no attacks of excitement, while the affectionate sentiments are often greatly exaggerated. The supposed fear of water is really only an inability to drink, the reaction of which may induce spasms of the throat. The majority of persons who die of hydrophobia die within four months, and ninety-nine per cent of them within a year, after the introduction of the poison. Cases of persons who recover after the first symptoms of the disease appear are extremely rare, if there are any. Of remedies there are none that are reliable, unless M. Pasteur's comes from the test triumphant.

Interesting Geological Formations in Kansas.—The March number of the Bulletin of the Washburn College (Kansas) Laboratory of Natural History consists of a paper by F. W. Cragin on the Cheyenne Sandstone and the Neocomian Shales of Kansas. The Cheyenne sandstone, resting unconformably on the Triassic of a few counties of southern Kansas, is so called for the present in default of precise knowledge of its stratigraph-

ic and paleontological equivalency. It contains fossils related to those of the Purbeck dirt-beds of England. It is overlaid by the Neocomian, which extends also into other counties, and is distinguished by its horizon of dark, slate-colored shale. This formation was first remarked by Prof. Jules Marcou in the Indian Territory some thirty-five years ago, but has received little attention, and is still very imperfectly known. Its thickness is variable, but probably nowhere exceeds one hundred and fifty feet. It is the same as the formation called by some geologists Comanche; but the term Neocomian is preferred on account of its referability to a European chronological equivalent.

The Work of a Complete State University.—The Coming of Age of State Universities is the title of the charter-day address of President T. C. Chamberlin, on the twenty-first anniversary of the University of Nebraska, in which the work of the complete State University is delineated. Such an institution will educate all its constituents in all varieties of useful knowledge—with a view to the common rather than to the individual good; it will endeavor to develop scholarship in its highest and most refined expressions, as well as in its more material and commercial phases—not for the sake of the scholar as such, but for the ultimate refinement and elevation of the common life of the whole people; it will promote a generous spirit of inquiry, a trained habit of investigation, an attitude of impartiality toward evidence, and a supreme regard for truth; will endeavor to serve all other parts of the public educational system by furnishing fresh knowledge, amply trained teachers, and the inspiration of higher educational opportunities; and will encourage, as an inherent factor and ultimate end of its efforts, those sentiments of regard for the common interests, those patriotisms of every-day life, that constitute the soul of superior citizenship.

Four Commencement Days.—In human life, says Dr. J. M. Bodine, in a valedictory address to the graduating class of the Medical Department of the University of Louisville, are four great commencement days—when we begin to be, when we begin to learn, when we begin to practice, and when we enter the existence beyond the grave. On the third of these days the author advises his students, if business does not come at once—"devote yourself to reading, and use every opportunity to do something professional. . . . See every operation, autopsy, and pathological specimen you can. Study botany in the fields, chemistry in the laboratory, and look into the invisible with your microscope. If seen thus engaged, the people will credit you with seriousness in your profession, and your employment, without patients, will be your best advertisement. . . . The route to preferment does not lie through the *salons* of society, the village sports, and is far away from the drink-shop. By complacency in yielding to the social and sportive, you will get the name of 'good fellow,' but when life is trembling in the parted scales sobriety and skill are at a premium. You must learn to labor and to wait. But, while waiting, work for knowledge and watch for opportunity. Win by application; woo by merit. . . . Be able to do something better than those around you, and the call to do it is certain."

Mountains of Arizona.—The region of the San Francisco and Mogollon Mountains of Arizona and New Mexico, as described by Dr. H. H. Rusby, comprises an elevated, open, somewhat barren table-land; a still more elevated forest belt; and a low, desert, mostly sandy plain. The table-land is traversed by a number of profound cañons, with precipitous walls a mile or more in height, and by many others of less depth, and is a never-ceasing source of surprises to Eastern visitors. "During the greater part of the year the surface is dry and desolate, of an ashy-gray color; but immediately upon the occurrence of the annual rains it changes with marvelous rapidity. Within three days after the first important showers, a distinct tinge of green is perceptible. In a week the surface is of an almost uniform light green; and in from ten days to two weeks it presents an appearance of great luxuriance. From this time on, until the occurrence of killing frosts, it is a paradise for the collector." The San Francisco Forest consists almost wholly of the *Pinus ponderosa*, and is one of the most beautiful for-

ests in existence, its effect being heightened by contrast with the neighboring deserts, from which it must be entered. It is also a very important timber resource. The San Francisco Mountains, in which it rises, have an elevation of about nine thousand feet, or some twenty-five hundred to three thousand feet above the general level, and give strikingly apparent evidence of their volcanic origin. Everywhere through the forest we encounter beautiful open parks, from a few acres to several miles in area; and in these the permanent water-supplies are usually found. The soil underlying the forest consists, for the most part, to a great depth, of loose volcanic rock, upon the surface of which no stream can form a permanent bed. The water-courses, therefore, are far beneath the surface, but reappear occasionally to form living pools of water, often a hundred yards or more in diameter. But during the heavy rains even this porous soil is not sufficient to absorb the entire fall of water, and it runs off through the hollows, washing out the loose material to form ravines and small cañons.

Ancient Peruvian Cloths.—Some textile fabrics of ancient Peru, in the collection of Mr. E. A. Barber, of Philadelphia, as described by Mr. W. Holmes, attest the high standard of taste and mechanical art which that people had reached. Most of the cloths and ornamented garments were wrapped around the dead, and may now be unfolded from the mummies. Others are contained in rolls, baskets, nets, and vases. The articles were chiefly of wearing apparel, and included caps, richly colored bands, and pendent ornaments for the head; mantles, shirts, girdles, sashes, and a variety of wraps for the body; braided sandals for the feet; blankets, hangings for doors and walls, shelter-cloths, ceremonial fabrics and banners, mats, baskets, bags, slings, nets, and other articles. Elaborate ornamental figures were woven into the cloths, and many were furnished with textile appendages. Some of the articles were woven whole, but it was customary to weave a garment in parts which were afterward stitched together. There was no cutting and fitting, or "weaving by the yard." All the specimens are purely American in character, with no suggestions of Spanish or other foreign influence. Animal and vegetable forms appear in the decorations, but animal forms predominate. The colors of the figures usually bore no reference to the colors of nature, but were chosen for their effect in the decoration. Great cleverness was shown in introducing the irregular forms of nature into geometric outlines without destroying them. A human figure "decked in plumes and clothed in garments of elegant patterns and varied colors" introduced in "a magnificent piece of gobelins," "is a triumph of skill and taste." In many pieces the figures were shown as transparencies when held up to the light. The people were exceedingly fond of fringes, "and some of their tasseled garments are marvels of elaboration." Great skill was shown in the manufacture of very attenuated articles, such as bands and cords. Animal figures were woven or knitted in the round, and colored in fair and close imitation of nature. Embroideries have been found of excellent quality and most pleasing design. Devices were used in dyeing, by means of which spots arranged in simple patterns were left uncolored; and painting on fabrics was extensively practiced.

Nursing as against Artificial Feeding.—Soxhlet remarks that, according to Lister's experiments, cow's milk, while in the udder, is free from those organisms which cause its decomposition after milking. The substances which cause fermentation of milk come from the outside, from the air or from matters with which it comes in contact. So, likewise, human milk, while in the mother's breast, contains no generators of fermentation. By suckling, the mother's milk is transmitted almost directly into the digestive organs of the child. In natural nursing, then, the child is fed germless milk; but, by the artificial method, with milk tainted by substances causing fermentation, and which frequently has already entered into a state of decomposition. The difference in the nature of this food as directly and as indirectly given is illustrated by the fact that calves fed from the pail, whether on the milk of the mother cow or on mixed milk, frequently suffer from diarrhœa during the first weeks, the best remedy against which is to allow them to suck the cow directly. We are

brought to the conclusion that, within certain limits, the substance of the food is of comparatively less importance than the conditions and manner of feeding and the degree of pollution through germs of fermentation.

Requisites of a Real Education.—In an address before the Teachers' Association of the McGill Normal School, Montreal, Prof. Wesley Mills, explaining his educational creed, assumed that the need of knowledge, or realization, is infinitely greater than the needs of expression, as witness the whole creation below man. An individual may be educated, though unable to read a sentence, write a line, or add up a column of figures. As a matter of fact, many men have become eminent among their fellows who could not do any of these things. Why has this been so? The reason is plain. These men understood the forces of nature, though they could not in all cases have stated their knowledge in our conventional forms of expression. The art and science of expression should be taught in schools, but should be subordinated to the acquisition of the knowledge of things. The moral and social nature of man should receive greater attention. The teaching of religious doctrines and the observance of religious forms are not practical in the public schools, but ethics by precept and example should be prominent from the day a child enters the school. A reverence for all kinds of truth should ever be impressed. Only one system of education—the Kindergarten—has ever met the nature of the child even fairly. The laboratory of the college is only the modified Kindergarten. Why is not the public-school teaching more like one of these? Because we have mistaken forms for knowledge and words for things, to a lamentable extent. "As our schools are now constituted, I must deliberately declare it as my conviction that they tend rather to quench than to excite a love for nature and a real knowledge of things, and to disgust young minds thirsting for a contact with realities. . . . I have known children that did not go to school till seven years of age, who had prior to that period learned to be good observers of what was going on around them, lose all love for natural objects after being at school a couple of years; and I do also know to my sorrow that many of the young men that enter our colleges neither know how nor care to observe. They prefer not to look Nature directly in the face, but try to see her through the medium of books, lectures, etc., and for this our school system is largely responsible." One of the remedies proposed for this evil is the simplification of the too ambitious school programmes. Abstract subjects, like history and grammar, should be left for future years. They take up the time that might be devoted to developing the intelligence through cultivation of observation and stirring the mind with the results of the exercise of the senses. Childhood is not the period of life for developing abstract notions, but for acquiring concrete ones. While in the abstract it is true that a knowledge of French, Latin, Greek, etc., may help to make one a better English scholar, the idea that an amount of these languages that would be of any value can be taught to the average pupil, without the neglect of other important work, is a delusion. The school should aim to enable the child to speak and write its mother-tongue readily, clearly, and elegantly. This will not be accomplished by teaching English grammar or foreign languages, but by contact with good models and practice. "Time is now frittered away on so many subjects that nothing is well done, and with the most disastrous effects on the habits of the learner. Our schools are dreadfully bookish."

Scientific Missions in the Olden Time.—The institution of missions abroad with scientific aims began in France, according to Dr. Henry, practically in the reign of Francis I. Among the earlier ventures of this class was that of the apothecary to Henri IV, who went all over the globe in search of the peculiar products of each country, especially medicinal and food plants. Earlier than he was the explorer who went to Brazil to study dyeing-woods. Among the most famous of the expeditions were those of Condamine, Dombey, Bougainville, and La Pérouse. There are still in the archives of the Ministry of the Marine copies of the instructions given to travelers and navigators in past centuries—"positively models of their kind, which could not be followed too

closely now." A botanical collection made by Paul Lucas, in the reign of Louis XIV, is mentioned by Prof. Bureau as still existing in the Museum of Natural History in Paris. Tournefort was sent by this king on a botanical expedition to the Levant, with very precise instructions—among others, to collect and observe the plants mentioned by the ancients. He formed a complete herbarium; and the artist Aubriet, who accompanied him, brought back a large collection of colored sketches. Both of these are preserved in the museum.

Primitive Marital Customs.—The proverbial hostility of a man or woman to a mother-in-law may be a survival from a social custom of our primitive ancestors similar to one which exists now among uncivilized peoples. This is the quaint and somewhat comic point of barbaric etiquette between husbands and their wives' relatives, and *vice versa;* they may not look at one another, much less speak, and they even avoid mentioning one another's names. Among the avoidance customs cited by Mr. E. B. Tylor, in a recent essay, is that described by John Tanner, the adopted Ojibwa, who tells of his being taken by a friendly Assinaboin into his lodge, and seeing how, at his companion's entrance, the old father-in-law and mother-in-law covered their heads with their blankets till their son-in-law got into the compartment reserved for him, where his wife brought him his food. Another comes from Australia. Mr. Howitt relates that he inadvertently told a native to call his mother-in-law, who was passing at some little distance; but the black fellow sent the order round by a third party, saying reproachfully to Mr. Howitt, "You know I could not speak to that old woman." This custom is not a rare one, for Mr. Tylor finds it to be practiced by sixty-six peoples in various regions, or more than one sixth of the peoples of the world, and he points out a relation between it and the customs as to place of residence after marriage. Another odd practice of certain savages is that of naming the parent from the child. Thus when Moffat, the missionary, was in Africa, he was spoken to and of, according to native usage, as Ra-Mary—i. e., father of Mary. Among the Kasias of India, Colonel Yule found the same rule; for instance, there being a boy named Bobon, his father was known as Pabobon. There are above thirty peoples spread over the earth who thus name the father, and, though less often, the mother. Mr. Tylor finds this practice to be closely connected with the custom of the husband residing in his wife's family. The *couvade*, which has been a favorite subject of ridicule for centuries, consists in the father, on the birth of his child, making a ceremonial pretence of standing in a relation to it similar to that of the mother. He is nursed and taken care of, and performs such rites as fasting and abstaining from certain kinds of food or occupation, lest the newborn should suffer thereby. This custom is known in the four quarters of the globe. How sincerely it is still accepted appears in a story of Mr. Im Thurn, who on a forest journey in British Guiana noticed that one of his Indians refused to help haul the canoes, and on inquiry found that the man's objection was that a child must have been born to him at home about this time, and he must not exert himself so as to hurt the infant. In the Mediterranean district the *couvade* has prevailed even into modern times. In the Basque country, Zamacolo, in 1818, mentions as but a little time since that the mother used to get up and the father take the child to bed. "Knowing the tenacity of these customs," says Mr. Tylor, "I should not be surprised if traces of *couvade* might be found in that district still." He accepts the interpretation of Bachonan that the *couvade* was originally an acknowledgment of paternity.

Ancient Men of the Potomac.—Prof. Otis T. Mason's survey of the archæology of the Potomac region covers that part of the valley which is situated below the rapids of the several tributary streams that mark the limits of tide-water. In the fresh-water portion of the lower Chesapeake drainage—the region between salt water and the cataracts—stone implements are found in the greatest profusion. It is easy to account for this when it is remembered that the country furnished abundant natural fruit supply. To one accustomed to exploration among the mounds of the Ohio Valley or in the West Indies, the stone implements are in appear-

ance disappointing. While here and there polished axes are found, the polished implement is the exception, not the rule, especially on higher ground. Again, comparing the chipped implements with those from regions abounding in flint, obsidian, and the finer varieties of the silex group, a large collection of them has a somewhat rude appearance. All this is due, however, to the material. The ancient Potomac dweller was restricted to bowlders of quartzite found in quantities inexhaustible all over his area, to veins of milky quartz outcropping here and there, and to an occasional quarry of soapstone. Types of pottery and impressions of woven fabrics contribute to our knowledge of the degree of advancement which the people had reached, and cast light on the tribal distributions. The most serious problem that faces the archæologist in this area has been proposed by Mr. Thomas Wilson, in the evidence of the existence of two periods of occupation—the one Palæolithic and ancient, and the other Neolithic and modern. While the camp-sites along the water-courses yield abundance of finely chipped arrow-heads, spear-heads, knives, polished implements, soapstone vessels, and pottery, the hills back from the river are wanting in the smaller, finer forms, but abound in coarser, flaked *artefacta*, mixed with broken implements and spalls.

The American Association.—The thirty-ninth meeting of the American Association will be held in Indianapolis, beginning Wednesday, August 20th. The general sessions and the meetings of the sections will be held in the new and commodious State-House, where also will be the offices of the Local Committee and of the Permanent Secretary. The hotel headquarters of the Association will be at the Denison House, and the preliminary meeting of the Council will be held there on Tuesday, the 19th. Interest will be added to this meeting by the fact that it will mark the fiftieth anniversary of the organization of the Association of Geologists and Naturalists, the parent of the American Association. The sessions will continue till Tuesday evening, the 26th, and a meeting of the Council will be held Wednesday, the 27th; Saturday, the 23d, will be given to excursions; and the excursions, after the close of the meeting, will extend to August 30th.

The officers-elect for the meeting of 1890 are:

President.—George L. Goodale, Cambridge, Mass.

Vice-Presidents.—A, Mathematics and Astronomy—S. C. Chandler. B, Physics—Cleveland Abbe. C, Chemistry—R. B. Warder. D, Mechanical Science and Engineering—James E. Denton. E, Geology and Geography—John C. Branner. F, Biology—C. S. Minot. H, Anthropology—Frank Baker. I, Economic Science and Statistics—J. Richards Dodge.

Permanent Secretary.—G. W. Putnam.

General Secretary.—H. Carrington Bolton.

Secretary of the Council.—James Loudon.

Secretaries of the Sections.—A, Wooster W. Beman; B, W. Leconte Stevens; C, W. A. Noyes; D, M. E. Cooley; E, Samuel Calvin; F, John M. Coulter; H, Joseph Jastrow; I, S. Dana Horton.

Treasurer.—William Lilly.

Auditors.—Henry Wheatland, Thomas Meehan.

A Papuan Bridge.—A native suspension bridge, crossing the Vanapa River, is described by Sir William MacGregor, British Administrator of New Guinea, as being, considering its locality and the primitive situation of the inland natives of the district, a remarkable structure. Advantage is taken of the narrowing of the river by the projection of a rocky point, so that the bridge is only about seventy yards long. At one end it is chiefly supported by a large banyan-tree, whence it starts at an elevation of about fifty feet above the pool below. It descends then in mid-stream to about twelve or fifteen feet from the water, and rises to about twenty feet on the right bank. It is then suspended to a tree not strong enough to hold it firmly. The tree is, therefore, supplemented by a post put in the ground, and this is again strengthened by a cross-bar against the tree, fixed by stays extending backward to trees behind. The material of the structure is rattan cane. Fifteen canes are used to form supports, those not long enough to cross the river having been built up by knotting. The floor of the bridge is formed of four of these canes. Above the floor are two "guard lines" on

each side at intervals of two feet six inches and two feet three inches, kept in position by split cane worked in a kind of basket-fashion. The whole would present, in transverse section, nearly the shape of a somewhat rounded V about five feet high and three and a half feet wide at the top. The top strands are kept apart by a cross-stick, the ends of which are tied to the top of each strand. Suitable platform approaches have been built at the ends, and the whole structure is strong and graceful.

Fine Art in the Workshop.—In a discussion of the relation of the fine arts to the applied arts, Mr. Edward C. Robins insists that the workshop is the place for applying those principles of beauty in art which are not taught there, but may be taught in the technical school, and which are necessary to give the worker the intelligence required to enable him to profit by the opportunities which the workshop alone adequately supplies to the handicraftsman. To secure the inculcation of these principles the natural and instinctive love of children for imagery, for stories, for penciling and coloring, for deft fingering should never cease to be cultivated; and every school should teach drawing as it teaches reading, singing, or ciphering. The free use of the pencil is of incalculable value in every sphere of life. Elementary knowledge is not enough, and the process should be carried on till proficiency results; and this can not be in the arts connected with architecture unless it culminates in complete mastery of decorative design and drawing from natural forms and the living model, as well as the practice of geometry and perspective. The pre-eminence of France in art generally, and its application to industry, seems to have resulted from the recognition of this important preliminary training.

Local Magnetism and Geological Structure.—The Relation between the Geological Constitution and the Magnetic State of the United Kingdom was discussed in a paper at the British Association, by Prof. A. W. Rücker and T. E. Thorpe. Having noticed certain abnormal variations in declination depending on the geological character of the district as engendering local or regional disturbing forces, the authors outlined two principal theories which had been proposed to account for the phenomena. Many igneous rocks and wholly basaltic rocks contain magnetic oxide of iron, and the deviations of the needle may be explained by the presence of such rocks, either visible on the surface or concealed beneath it. The other explanation associates the deflections of the needle with disturbances of the earth's currents of electricity produced by irregularities in the geological constitution of the country, especially with geological faults. The authors were of the opinion that on the whole the theory of the action of magnetic rocks agrees best with the observed facts; and they showed that the United Kingdom can be divided into a number of magnetic districts, in which the directions of the disturbing forces are evidently closely connected with the geological constitution.

The Eyes and Headaches.—Headaches are usually associated with disorders of the system or of important organs. It is pointed out, however, by Dr. J. J. Chisholm, in a paper on Persistent Headaches and how to cure them, that a large number of head discomforts occur in which no acute inflammatory condition exists, and no fault can be found with the general health. In many of these cases, especially in such as are relieved by stopping work, the cause of the disorder may be traced to the eye. This may be the case even when no pain is felt in the eye itself, and where no weakness of vision has been detected. The true headache eye is known as an *astigmatic* one, or one in which the light, through defective change of the lenses, fails to be concentrated to a point on the retina. It is a frequent product of the schools as they are now managed. Aside from abandoning the use of the eyes, which is impossible, the only remedy for the astigmatic headaches is found in wearing suitably chosen glasses.

Musical Visions.—The story is told in Nature of a young woman who has distinct visions of various objects at the sound of different musical instruments. The playing of the oboe calls to her eye a white pyramid or obelisk running into a sharp point, the proportions of which vary with the qualities of

the note. All the notes of the cello, the high notes of the bassoon, trumpet, and trombone, and the low notes of the clarionet and viola suggest a flat undulating ribbon of strong white fibers. The tone of the horn calls up a succession of white circles of graduated size, overlapping one another. The circle and the ribbon float past her horizontally, but the point of the obelisk seems to come at her. In an orchestra, when the violins strike up, after the wind band has been prominent for a time, she sees often a shower of bright white dust or sand. If she knows the scoring of a piece well, the various effects slightly precede the instrument they belong to; but the objects are vague and faint till the sound begins. Sometimes, if an oboe passage has an intense or yearning character, the white point comes so near her, and moves so rapidly, that she thinks it must wound her.

Who Should study Chemistry. — In an article in which it is shown what small remuneration is obtained for ordinary chemical work in England, the editor of The Chemical News says: "It must not, however, be supposed that we are seeking to dissuade the young from the study of chemistry altogether. To three classes, who we would fain hope are becoming more numerous, we must recommend it most strongly. In the first place, to all who aim at reaching something higher than a mere board-school grade of mental culture, we should recommend it, quite irrespective of possible material benefits, as a means of intellectual training. Chemistry teaches us the important arts of close and accurate observation, and of drawing correct inferences from the facts recognized. These important arts can never be mastered by the most prolonged study of classics and mathematics. Hence, if we regard education as intellectual discipline rather than the mere absorption of a number of facts, we shall find some one of the branches of natural and physical science absolutely essential and indispensable. And under most circumstances chemistry will prove the most appropriate subject. Another class which we should like to see largely recruited consists of men in independent circumstances who have the leisure needed for taking in hand those many scientific problems which are often neglected because they are not immediately remunerative. Such men too commonly waste their time in dissipation, in the pursuit of more wealth, or in making mischief. Now, if they possess the needful ability, we had much rather see them at work in the laboratory. The last class to whom we would especially recommend a thorough study of chemical principles are those who are looking forward to employment in the chemical arts, whether as proprietors, managers, foremen, etc. It is a misfortune when men who occupy such positions depend merely upon rule of thumb and traditional recipes. If these three classes do what we believe is their duty, our national manufactures and our national habits of thought will alike undergo a needed improvement."

Marriage Ages in England.—For the last seventeen years the persons who have married in England have been older each year. In 1873 the men who married averaged 25·6 years of age, and the women 24·2; in 1888 the averages were respectively 26·3 and 24·7 years. The mean age at marriage in the professional and independent classes is seven years more advanced for men and four years more advanced for women than among miners—in fact, generally speaking, the higher the class the later the age at which marriage is contracted. These results were presented to the Royal Statistical Society in a recent paper by Dr. William Ogle, who said further that more persons remain permanently celibate in the upper than in the working classes. He had found that fewest men abstained altogether from matrimony among shopkeepers, to whom wives were almost a necessity. Next to them came the mechanics and laborers, while the professional and independent class had a proportion of permanent bachelors far above the rest.

Healthful Walls and Ceilings.—A requisite to the healthful condition of ceilings and walls, according to Prof. R. C. Kedzie, is the preservation of their respiratory quality, or of a degree of porosity that will permit a free transpiration of air through them. While this exists unimpaired, impurities lodging upon them are naturally consumed, and they remain clean and wholesome; what-

ever tends to obstruct transpiration promotes the accumulation of impurities. For this reason, even paint, though it may be intrinsically harmless, is objectionable. Paper is positively objectionable, because itself collects impurities and retains them; the substances with which it is prepared and decorated do the same; and the paste with which it is attached responds to all dampness and atmospheric influences, and readily becomes moldy. Kalsomine is faulty, because it is prepared with glue, and that, besides stopping the pores in the plastering (or "strangling the wall"), is liable to decay. No wall coating can be more healthful than a lime-wash. But, since that is inconvenient on account of its rubbing off, an excellent substitute is recommended by Mr. M. B. Church in calcined plaster of Paris, which hardens at once, forming a fixed shell of perfect porosity.

NOTES.

A CORRECTION.—By a slip of the pen which also escaped notice in the proof-reading, Prof. Weismann is made to say twice in the second paragraph of page 357 of our July number "cerebellum" where "cerebrum" was intended. Read—"if, again, we were able to remove all the other parts of the cerebrum," etc., and "with the rest of the cerebrum was taken, etc."

THE meeting of the British Association for 1890 will be held at Leeds, September 3d to 10th, under the presidency of Sir Frederick Abel. The sectional presidents will be: A, Dr. J. W. L. Glaisher; B, Prof. T. E. Thorpe; C, Prof. A. H. Green; D, Prof. A. Milnes Marshall; E, Sir R. Lambert Playfair; F, Prof. Alfred Marshall; G, Captain A. Noble; H, Dr. John Evans. Evening addresses will be given by Mr. E. B. Poulton on Mimicry; Prof. C. Vernon Boys on Quartz Fibers and their Applications; and Prof. Perry will lecture to the working classes on Spinning Tops.

A NEW food is described in the Kew Bulletin as used by the poorer classes in northern India. It is called *phog*, and is made from the flowers of the plant *Calligonum polygonoides*. They are eaten mixed with flour, or separately with salt and condiments They are rich in nitrogenous compounds, and somewhat resemble the seeds of the edible amaranths and buckwheats, only that in them sugar replaces starch.

A VISIBLE illustration of the figures produced by sound-waves has been devised by Mrs. Watts Hughes, in what she calls "voice-figures." They are practically Chladni's figures, produced in a viscid medium. Semi-fluid paste is spread over an elastic membrane stretched over the mouth of a receiver. A single note sung into the receiver throws the paste into waves and curves. The patterns formed are photographed immediately after production, or are transferred as water-color impressions while the membrane is still vibrating. Perhaps the most interesting figures are the "daisy forms," in which "the number of petals increases as the pitch of the note that produces them rises."

MR. ALBERT KOEBELE, who was dispatched to Australia under the direction of the Entomologist of the Agricultural Department to obtain natural enemies of the "fluted scale" of the orange (*Icerya purchasi*), brought home an insect, the cardinal vedalia, which has proved very efficient. It has already multiplied to such an extent as to rid several groves from *Icerya*, and is looked upon as promising immunity in the near future for the entire State of California. In fact, Dr. Riley fears that it will do its work so well as to leave no field for other insects which Mr. Koebele procured, and which it is desirable to cultivate for the sake of having a variety.

IN a paper in the Connecticut Pharmaceutical Association, Mr. D. G. Stoughton appears to have arrived, by a way of his own, at the conception of the identity of electricity with the other physical forces, heat and light, now demonstrated by Mr. Hertz's experiments. He regards them as resultants of the obstruction of ether motion by matter. Molecular motion, intense within the sun, is supposed to be transformed at the confines of the gaseous envelope surrounding that body into ether motion, which, passing through the ninety million miles of ether to the confines of our atmosphere, is obstructed by the molecules of atmosphere, and gives rise, according to the measure of the obstruction, to electricity, light, and heat.

HOLMGREN'S test for color-blindness is the one recommended by those who have given the subject most attention. There are three parts to the test, which consist in picking out from a lot of wools all those skeins that match given ones in color. A pale green is the test-color first used, then a dilute purple, and finally a bright red. The person is not required to *name* any colors, as this is a different matter from distinguishing them.

A WRITER in Le Monde de la Science et de l'Industrie recommends, as an excellent insoluble plastic material, a mixture of cheese or casein or albumen and lime, well worked up. It is insoluble in hot water. Artistic effects may be obtained by molding, and it is easily colored.

A MODE of filling teeth that has recently been made practical in England is by inlaying porcelain. The cavity is made perfectly cylindrical, and a bit of specially manufactured porcelain is turned to the exact size to fit it. The inlay is then secured in its place with sandarac varnish or very fluid white filling. After this is set, the surface of the inlay is ground to a proper contour and polished. An oblong cavity can be filled by inserting two inlays. Of course, this method can not be used, nor is it specially desirable, for all cavities, but few will deny that a filling which matches the natural tooth in color is far less conspicuous, and more agreeable to see, than the glaring patches of yellow metal, which are only excusable as saving a worse disfiguration.

THE sum of six hundred dollars has been appropriated by the National Academy of Sciences for the construction of apparatus to aid Prof. Cattell in his researches on the time of cerebral operations. With the cooperation of Dr. S. Weir Mitchell, Prof. Fullerton, Prof. Dalley, and others, researches are in progress at the University of Pennsylvania on the rate at which impulse travels in motor and sensory nerves and in the spinal cord, the time of reactions and of more purely mental processes, memory and the amount forgotten in a given time, the time of bodily and mental processes in diseases of the nervous system, and in other directions.

THE effects of steam in the destruction of bacteria do not depend, according to the researches of Von Esmarch, so much upon the temperature as upon the degree of saturation of the steam. If there is air with it, the power of destroying organic germs is very much diminished.

A COMMITTEE has been formed in Paris for the erection of a statue of the late M. Boussingault.

DURING some experiments as to the temperature of snow at different depths, it was found that very little variation occurs in the lowest layer, next the ground, while the temperature of the upper layer is considerably higher.

A NOVEL aspect of bacterial life is suggested by A. de Barry in his Comparative Morphology of the Microfungi. Writing of Béchamp's theory of the microzymes, the author says that these minute bodies not only develop independently after the death of the parent organism, but enjoy an almost unlimited duration of vitality, since they may lie during entire geologic periods in such a rock as chalk, and yet retain the power of development.

DR. R. ASSMANN, in a communication to Das Wetter, names, with especial reference to influenza, as the climatic conditions favorable to the dispersion of organisms in the air: Dryness of the ground and absence of snow; infrequent rain and that light; presence of fogs or low clouds; and predominance of high barometric pressures, with imperfect intermingling between the strata of the air.

CELLULOID artificial eyes are cheaper than those of glass and have a good appearance; but Dr. Meurer, of Lyons, states that after three or four months they are liable to cause serious irritation, probably as a result of some chemical change. He has repeatedly seen this inflammation allayed by simple antiseptic treatment after the removal of the celluloid, reappearing, however, as soon as the old eye was put in again, but remaining absent if a glass eye was substituted.

THE Scientific Publishing Company, New York, announce as in preparation Systematic Mineralogy, based on a Natural Classification, by Dr. T. Sterry Hunt.

THE French Association for the Advancement of Science will hold its nineteenth annual meeting at Limoges, from August 7th to 14th. A number of English scientists have been invited, who will be guests of the municipality of Limoges.

IN a recent article on cyclones, Mr. H. Habernicht shows that, if the globe were covered with water, the general circulation of the air would be very regular. He states as the primary cause of cyclones the obstruction offered to the wind by the continents to the east and west of the Atlantic; and, secondly, the constant high barometric pressure over the continent and in the arctic regions during the winter.

DR. FITCH, former State Entomologist of New York, gives a remarkable instance of the long imprisonment of insects without loss of life. In 1786 a son of General Putnam, residing in Williamstown, Mass., had a table made from one of his apple-trees. Many years afterward the gnawing of an insect was heard in one of the leaves of this table. The noise continued for a year or two, when a large, long-horned beetle made its exit therefrom. Subsequently two more beetles issued from the same table-leaf, the first one coming out twenty and the last one twenty-eight years after the tree was cut down.

SOME recent explorations in the famous Adelsberg cave, Carniola, Austria, show that the Ottaker cave discovered last year is a continuation of the larger one. The exploration was made by a party of Adelsberg citizens and occupied six hours. It was necessary to use a boat several times. The explorers think the cave very much larger than was formerly supposed.

IT is proposed in Paris to name a new street after Darwin.

At a recent meeting held at Madrid, to consider the celebration of the four-hundredth anniversary of the discovery of America by Columbus, a grand committee was elected which will act in concert with the Spanish Government, and a committee previously appointed, and presided over by the Duke of Veragua, a lineal descendant of Columbus, and the present Minister of Public Works. It is proposed that the centenary shall be celebrated, if possible, at Madrid. Genoa is also making preparations to celebrate the same event.

The annual address of Mr. Charles F. Cox, as President of the New York Microscopical Society, is published in the Journal of the Society for April, 1890. The subject is Protoplasm and the Cell Doctrine, and the essay is a historical account of the development of scientific views in this field.

A bill has been introduced by Sir Henry Roscoe in the British House of Commons authorizing the Board of Managers of any public elementary school to provide technical instruction for its pupils at any suitable place, attendance at which shall be deemed to be attendance at the public elementary school.

The influence of ground-water and shallow wells in relation to public health is discussed in a recent paper by Dr. W. B. Featherstone. A considerable number of diseases are shown to be associated with defects in ground-water and its impurities, as well as of shallow well water; but the exact amount of influence exercised by these properties on the production and spread of disease has yet to be measured.

Wood-stone is the name of a new compound material composed of sawdust and calcined magnesia. The mixture, having been well worked up with water, is put into molds and pressed into whatever shape may be desired. It is incombustible and impermeable to water, is susceptible of a fine polish, and is adaptable to numerous uses.

OBITUARY NOTES.

Dr. Herman Shultz, Director of the Observatory and Professor of Astronomy at Upsala from 1878 to 1888, died in Stockholm May 8th. Of his numerous astronomical publications, the best known is Micrometrical Observations on five hundred nebulæ, which was published in England in 1874.

Prof. W. K. Sullivan, President of Queen's College, Cork, well known as a chemist, died May 12th, aged sixty-eight years. He succeeded Sir Robert Kane to the presidency of the college in 1872.

Mr. John Gunn, of Norwich, an English geologist of local reputation, died during the last week in May, in his eighty-ninth year. He was regarded as the chief authority on the formation known as the Cromer Forest Bed, and a most indefatigable and successful collector of its organic contents, and had an extensive knowledge of all the geological formations of East Anglia. He was also interested in antiquarian research. He made a fine collection of fossils illustrating especially the Pliocene mammalian life of England, and presented it to the Norfolk and Norwich Museum, where it occupies the "Gunn Room."

Mr. W. S. Dallas, Assistant Secretary, etc., to the Geological Society of London, and editor of its Quarterly Journal, died May 28th, aged sixty-six years. In early life he became interested in zoölogy, more particularly in the study of insects, relative to which he published many papers in the Transactions of the Entomological Society. In 1851–'52 he published a catalogue of the hemipterous insects in the British Museum, and in 1856 a Natural History of the Animal Kingdom. His later labors were in the direction of scientific literature rather than of original research—of translating, editing, etc.

The death is announced of Dr. F. Soltnedel, Director of the Botanical Station at Samarang, in Java. He was conspicuous in the field of applied botany.

Dr. Karl Jacob Loenig, Professor of Chemistry at the University of Breslau, and author of several eminent works on chemistry, died March 27th, in his eighty-eighth year.

Victor, Ritter von Zepharovich, Professor of Mineralogy at the German University of Prague, died February 24th. He was author of the Mineralogical Dictionary of the Austrian Empire, and of many valuable mineralogical and crystallographical works. He was fifty-nine years of age.

Dr. Karl Emil von Schafhäutl, Professor of Geology, Mining, and Metallurgy in the University of Munich, died in February last, in the eighty-seventh year of his age. He was an eminent physicist and geologist, and a theoretical musician of some note, and was keeper of the geognostic collection of the Bavarian state, and a member of the Academy of Sciences.

The death is announced of M. Soret, an eminent chemist and physicist, of Geneva, Switzerland. He was associated with Regnault in his researches on vapors and determinations of the specific heats of the gases. He afterward published in Switzerland a work on the density of ozone, and investigated the rotatory polarization of quarts. Another of his publications relates to the cause of the blue coloration of the Lake of Geneva.